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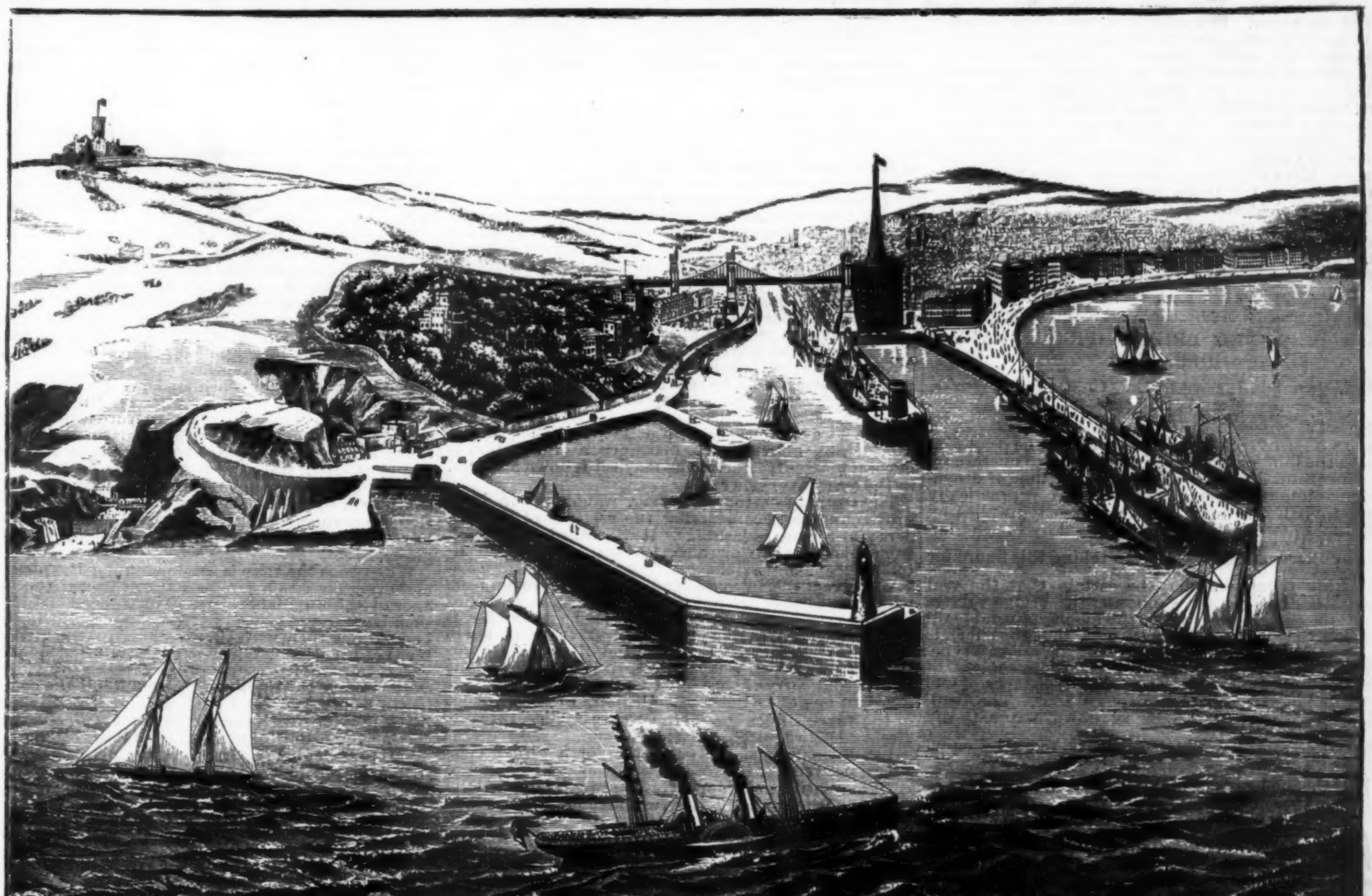
DOUGLAS HEAD SUSPENSION BRIDGE AND TOWER.

To the south of the town of Douglas, Isle of Man, rises a commanding hill which forms a favorite resort of visitors as well as of residents. This is Douglas Head, which, however, with all its attractiveness, has one serious drawback, and that is its inconvenient situation with regard to the town. Although the two are in close proximity, access to the head is neither easy nor direct. To reach it from the town, those wishing to do so must either take the ferry steamer or a small boat, or must tramp along the North Quay, over the bridge at the top of the harbor, and back along the South Quay, and in each case they have, finally, a stiffish climb to reach the castle. To remedy this drawback, the Douglas Head Suspension Bridge Company, of Devereux Chambers, Temple, London, has been drive round the head to Port Soderick, a picturesque bay and glen about three miles distant. By these means the interests of the town and island will be served directly. Indirectly, the interests of both will be promoted possibly to a far greater extent. So far, these improvements will largely appeal to the teeming visitors to the Isle of Man, but there is a consideration beyond this to which the bridge aptly lends itself. The slopes of Douglas Head facing the sea and harbor are admirably adapted for residential purposes, and the land so situated would doubtless have been studded with villa residences long ago, had there been an easy and direct means of communication both for vehicles and foot passengers between the town and this suburb. This the bridge will unquestionably afford, and, that being so, the development of Douglas Head as a high class residential district should follow as a matter of course.



DOUGLAS HEAD SUSPENSION BRIDGE AND TOWER.

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formed to carry out a scheme for a high level suspension bridge to connect the town with Douglas Head. At the outset, however, a difficulty presents itself. The land on the town side lies low, forming, as it were, a plateau from whence the head springs on the southern side of the harbor, so that there is no feasible approach on the north side. The difficulty, however, has been ingeniously and effectively met by Mr. Thomas Floyd, C.E., of Victoria Mansions, Westminster, whose design for a bridge and approach tower we illustrate. This scheme will provide a ready means of access from the town to the head, not only for pedestrians, but for vehicular traffic. The approach at the northern end of the bridge will be by means of a circular tower, within which will be a spiral roadway, laid with an easy gradient, while the southern end of the bridge will debouch upon Douglas Head, some distance up the hill. Rising from the top of the circular tower, there will be an elegant spire-like structure, which will be surmounted by an observatory and a light tower, from which a powerful electric light will illuminate the harbor, the bay, and all parts in their vicinity. The bridge and tower will also be lighted by the same agency.

The upper portion of the circular tower above the level of the bridge will form a large circular promenade with a band stand in the center, while within the tower will be a concert hall and rooms for various entertainments. The platform of the bridge will also be utilized for the purpose of a high level promenade. The bridge itself, moreover, at the southern end will form a continuous line of communication with a proposed marine

Turning from generalities, we will now proceed to consider the engineering details of the scheme, into which we have recently been afforded the opportunity of looking. The bridge will cross the harbor at a point opposite the Imperial Hotel (one of the piers being erected on its former site), and will connect this side with the rising ground on the opposite side, crossing the Douglas Head road at a clear elevation of about 70 ft. above the road level. From that point the southern approach will descend by a gradual fall until it reaches the roadway at the rear of the Fort Anne Hotel, where it will form a junction with that road. The headway above high water mark will be 135 ft. clear from under side of the main girders. The approach tower and spiral roadway will consist of two concentric rings of wrought iron columns firmly braced together by wrought iron girders and ties. The diameter of the external ring of columns will be about 172 ft., and that of the inner ring about 92 ft., leaving a clear annular space of 40 ft. in width all around, in which the spiral roadway will be constructed. The northern approach will commence in Bath Place (on the site of the existing circus), and will arrive at the deck level by six turns of the spiral roadway. The head room at any one point will be about 17 ft., and the width 40 ft. The roadway will be carried by a series of radial and circumferential girders running from a column in the inner circle to an opposite column in the outer circle, or at right angles to the roadway. The circumferential girders will form a curb on either side of the roadway, or a double spiral of six turns, thus joining each individual column in both rings to its neighbor on either side. To these rings of girders will be attached the handrail on either side of the road. At the summit of the spiral road a platform or landing will be formed of ample width to allow vehicles to pass each other and turn on to the bridge, the landing being supported by an iron pier. This pier will form the connection between the summit of the roadway and the bridge proper. Rising from the top of this circular tower, and resting on the inner ring of columns, will be an elegant look-out tower carried up to a height of 450 ft. above the ground level. It will be constructed of light iron or steel ribs, braced together vertically and horizontally. This structure will be surmounted by an observatory and a light chamber, approached by a spiral staircase in the axis of the spire.

The bridge itself will consist of four spans. The center or main span over the harbor will be 400 ft. in length, with a connecting span of 148 ft. to the approach tower, and two of 200 ft. and 115 ft. respectively on the opposite shore, passing over the Douglas Head road. The bridge, which will be 40 ft. in width, will be supported by three piers of masonry and one of iron, the latter forming a connection between the approach tower and the adjacent Imperial Pier. The two extreme spans—viz., the connecting span of 148 ft. and the shore span of 115 ft.—will be formed of independent girders of sufficient strength to carry the maximum load, but the main span of 400 ft. and the 200 ft. span will be of the suspension type, all four spans having a roadway 40 ft. in width extending from end to end of the bridge. The cables supporting the main bridge will be composed of steel wire ropes formed into cables of about seven strands each, six cables being used on each side of the bridge. These will be carried on rocker frames built into the masonry of the piers to allow for the free expansion or contraction of the wires due to changes of temperature, the extreme ends of the cables being anchored in the ground. From these cables, and attached to them by clips, will hang the suspending rods supporting the cross and main girders of the bridge. These rods will be provided with adjusting screws at their lower ends, in order that the dead load of the bridge may be evenly distributed over the entire length of the cable. The main girders of the bridge will be in all cases lattice girders, the top and bottom booms being made up of channel bars and plates. To the vertical members of these booms will be riveted the struts and diagonal ties forming the ties of the girders. The ends of the main girders of the

center span, and also of the 300 ft. span, will be specially constructed with hinged joints or bearings both at the center and on the piers, in order that they may adapt themselves to the various loads passing over them. The bridge is designed to sustain a live load of 84 lb. per square foot, and the dead load is assumed at 56 lb. per square foot. The strain on the chain at the center will be 848 tons, and at the piers 873 tons. There will be six cables on each side of the bridge, each cable having seven strands 2 in. in diameter. The depth of the main girders will be 12 ft. 6 in. The wind bracing is designed to resist a pressure of 50 lb. per square foot. The total approximate weight of the whole bridge is 1,100 tons. The main girders of the center span will weigh about 216 tons. There will be required 99,130 ft. run of wire rope 6 in. in circumference, weighing about 243 tons. The approximate weights of the tower approach road are as follows: In the upper spire, 220 tons; in the lower, 1,880 tons; total, 2,100 tons complete.

An investigation of Mr. Floyd's designs satisfies us that the structure, as a whole, is an original conception, the tower being on the principle of a steeple rising from a massive church tower. The construction of this tower in iron we consider to be perfectly feasible. The main columns, or supports, are thirty-six in number, arranged in two rings, the outer containing twenty-four and the inner twelve columns. They are to be square in section, constructed of wrought iron plates and angle irons, and, from the nature of their disposition, they would be rigidly braced together by the longitudinal girders in the plane of the cylinder, and transversely by the girders carrying the roadway. The erection is equally simple, for, as soon as the first lengths of five columns are set up on their bases, and the first roadway girders fixed between them, they would form in themselves a stable structure on which a traveling crane could be placed which would steadily move up the inclined road and lift and set the columns and girders in front of it, until it arrived at the upper floor of the tower. It would then rest there, and lift the material for the spire, which would be erected with a lighter crane and derricks. In this way it is anticipated that there will be no difficulty whatever in raising the spire to the proposed height. The combined tower and bridge will constitute a feat of special engineering interest, and will prove a great convenience, without marring the effect of the surrounding scenery, as a glance at our illustration will show. The House of Keys will shortly be called upon to consider this scheme, and, if it be true to the interests committed to its charge, it will sanction a project which not only has the merit of being original and perfectly feasible, but which, if carried out, cannot fail to prove of the greatest benefit to the island by promoting its material progress.—*Iron.*

[Continued from SUPPLEMENT, No. 729, page 11642.]

THE CHANNEL BRIDGE—PRELIMINARY DESIGNS.*

By Messrs. SCHNEIDER & CO., Creusot Iron Works, and H. HERSENT.

Section 2. Calculation of the machinery employed in fitting up.—Buffers.—The momentum to be deadened in case the buffers should be called upon to operate by movements of the sea occurring at the time of disembarking on to the piers may be regarded as practically equal to half the mass of the bridge multiplied by half the square of the speed acquired by the end imparting the shock, viz., $\frac{PV^2}{2g}$. In taking this figure for a starting point, one may be certain that the real amount is exceeded, for, supposing the bridge rotates about its center, the sum of the momenta would still be below that figure. Suppose, now, that the shock is to be relieved by twelve buffers of the railway type, arranged within each of the piers, the strongest of these buffers are capable of moving a distance of 0·10 meter and of carrying a load of eight tons. The available labor, therefore, can be set down as practically equal to $\frac{8 \times 12 \times 0{\cdot}1}{2}$, which quantity must be equal to half the momentum, viz., to $\frac{2400}{19{\cdot}62} v$ 2. Therefore, v equals 0·198 m. per second. Now a swell sufficiently long to influence the barges corresponds, as is well known, to a time of oscillation of about 3". Thus, the average velocity, as worked out above, would correspond, in a similar oscillation, to a rise of the sea of 0·594 m. per second. This, however, is an amount of lifting which may be avoided in effecting the discharge, especially in the summer. A more precise calculation can be made by taking the force of inertia into account, but it seems unnecessary to dwell further on this point. It will be easily seen that there will be no difficulty in deadening the impact due to the velocity imparted by the waves.

Barges.—The case more particularly considered here is that of the heaviest span, it being the one attended by most difficulties. The first condition to be fulfilled as regards the barges is to make it impossible for them to capsize, and to insure their stability. This object can be attained by placing the center of gravity of the whole below the longitudinal meta-centrum. It can be taken for granted that the center of gravity of the empty hulls of the barges will be 1 m. above the floating line of the load, since they will be surmounted by a superstructure rising up to 20 m. above the floating line and since they will, when fully charged, rise to 4·15 m. above the water, their draught being 6·50 m. This being so, the bridge weighing 3·200 tons per barge and having its center of gravity 49 m. above the water, the general center of gravity, according to the calculation of weight, will be

$$\frac{3{\cdot}200 \times 49^m \times 2{\cdot}300 + 1}{5{\cdot}500} = 29 \text{ m.},$$

the draught of the barges being 6·50 m.; the minimum height of the longitudinal meta-centrum, above the center of the keel, will be about 32 m. Now, supposing that barges are used measuring 22 m. in width, and 70 m. in length, the height of the meta-centrum, with a displacement of 5·500 tons, will be about 40 m. Thus, stability will be amply provided for, and the distance of the center of gravity from the meta-centrum will be 8 m. This distance is sufficient, as will be shown further on, to insure stability under a wind coming transversely upon the bridge with a considerable pressure. The surface the bridge will offer to the wind in that direction will be 87·50 square meters, and the center of pressure is situated 21·35 m. above the girders, that is, 46·5 m. above the surface of the water. If p be the pressure of the wind per square meter, the momentum of the wind in relation to the floating line will be $8{\cdot}750 \times 46{\cdot}85 \times p$. If θ is the incline assumed by the barges, then $P(R-A) \sin \theta = 8{\cdot}750 \times 46{\cdot}85 \times p$. P being the total displacement, and $R-A$ being the distance of the center of gravity from the meta-centrum, this distance we have assumed to amount to 8 m., and P is = 16,500,000. Now, it is desirable that the immersed end should not go down deeper than 2^m, 50; sin A must not exceed $\frac{2{\cdot}5}{35}$. It follows that the pressure per unit of surface which the whole structure will be able to sustain will be equal to

$$p = \frac{16{,}500{,}000 \times 8 \times 2{\cdot}5}{8{\cdot}750 \times 46{\cdot}85 \times 35} = 23 \text{ kilos.}$$

Thus even a violent storm could not possibly capsize the barges. But, granting that this point has been sufficiently illustrated, it may be questioned whether the bridge will not run the risk of being deformed under the strains it will be subjected to by the barges themselves during its transport, especially if the operation is not carried out in perfectly fair weather. It is obvious that if there is but little sea running, so that the waves are insufficient to influence the barges themselves, the whole operation will proceed as if they floated upon a perfectly smooth sea, so that no anomalous strains would ensue.

As to traction, or those strains that will result from gyration, it will be readily seen that they will be of no great importance, if all the operations are performed slowly—*e. g.*, the towing power necessary to tug the bridge at a speed of 8 knots will not exceed 150 tons, even if a very sharp wind happens to add to the resistance proper, such wind exercising a pressure of 10 kilos. per square meter, the towing power need not exceed 160 tons.

Now, the bridge has been calculated to resist more considerable transverse strains than that. While one may reasonably depend on having fairly good weather in the channel during the summer, it may happen, nevertheless, that the barges, upon leaving the port, may encounter a considerable swell, at least in length, which, although not very noticeable, may exercise on a girder more powerful strains than those provided for in the preceding calculations. Thus, it may happen that the swell exercises on one of the barges a lifting strain that will be transmitted to the bridge. This strain will be equal to the floating surface of the barge multiplied by the distance between the ordinary floating line and the medium floating line, determined by the section of the wave.

Now as the floating surface extends over about 1,000 square meters, it will be seen that a wave that would cause the floating line to rise 50 cm. would cause a thrust of 500 tons.

Such a wave, however, would have a lifting power considerably above 50 cm., inasmuch as its section is never a horizontal line. One may set it down at 75 cm. in the least favorable case.

The strain of 500 tons, however, would not in itself prove dangerous, considering the sections of the girders and the use of lashings. It will thus be seen that, from this point of view also, the transport would be by no means impossible.

We have hitherto considered only those stresses from which the girders are naturally protected, such strains acting in the same way as those which the girder is originally destined to withstand; but the girders will be exposed, besides, to another kind of strain, the torsion strain, which they will sustain whenever the barges that carry them tend to take up positions at different angles to the perpendicular, in consequence of the varying inclines of the waves. Those are the stresses that require special attention.

Let us then consider the portion of a girder comprised between the two floats. They will assume a certain relative position, corresponding to an angle of torsion of the bridge, θ, and will assume the inclines, θ' and θ'', respectively, in relation to the liquid surface upon which they float.

If we call α the angle formed by the two floating surfaces, we obtain $\alpha_1 = \theta_1 + \theta' - \theta''$. On the other hand, the moment of stability of the first barge is $P(R-A)\theta'$, that of the second $P(R-A)$, and the couple which counterbalances the twisting strain is $P(R-A)(\theta' - \theta'')$ or $P(R-A)(\alpha - \theta_1)$. It is equal to a moment of torsion of

$$\frac{\theta_1}{l} I_p G = P(R-A)(\alpha_1 - \theta_1).$$

But, on the other hand, if σ be the effect of the strain upon the fiber supporting the heaviest load, this effect is proportionate to $\frac{\theta_1}{l}$ *i. e.*, to

$$\frac{P(R-A)_1}{I_p G + l\, P(R-A)} = \frac{\alpha_1}{\frac{I_p G}{P(R-A)} + L}$$

From this expression we cannot yet obtain the value of σ; but we may infer from it that it is desirable, within certain limits, to multiply the number of barges. Supposing, in effect, that they are uniformly divided, the displacement, P, of each will be proportionate to the distance between them, as l and $\frac{P}{l} = c$. Let h be the distance of the center of gravity from the remotest fiber; we obtain

$$\sigma = G h \frac{\alpha_1}{\frac{I_p G}{P(R-A)} + l} = G h \frac{\alpha_1}{\frac{I_p G}{lc(R-A)} + l}$$

The value of l corresponding to the maximum of σ is

$$l = \sqrt{\frac{I_p G}{c(R-A)}}$$

By this formula a far greater length than that of the girder will be found. As l diminishes, σ decreases too; thus it will be seen that it is desirable to increase as far as practicable the number of barges. The necessity for the girder to rest upon parts capable of a local resistance leads to the adoption of the number *three* for every 9·580 tons. Less than this cannot be taken in the case of the other spans. Given a distance between the barges l, and the angle, α_1, of the floating surfaces of two consecutive barges, the corresponding value may be calculated from σ.

But an easier method is to find out at what angle α_1, σ equals a torsion of 6 kilos. per square millimeter. It will then be found that α should be equal to something more than 200 deg.; we are therefore justified in concluding that the torsion produced, even by very powerful waves, will only cause perfectly insignificant strains. All the preceding calculations are naturally only approximate; they nevertheless permit the inference that the transport of the spans is quite possible.

Section 3. The Fitting of the cantilever arms.—We here treat of a method of putting into position the central spans and overhanging trusses, so as to avoid the employment of hydraulic cranes, which have hitherto been indispensable.

The necessity of raising the bridge by hydraulic cranes each time one places a ring of the columns into position necessitates a series of alternative manipulation, requiring a great deal of time and trouble. It is easy enough, on the contrary, to mount the columns separately by small sections by the aid of hoisting gear of less power; but as the carriage of the spans on floating barges is not to be thought of, it being too difficult to thus bring them into a position that will permit them to be raised to the place they are to occupy, the result is that it is necessary to fit up these spans at the required height straight away.

The idea might at first sight suggest itself that the piers already constructed should be used as supports. For by surmounting them each separately by a platform of sufficient size to insure stability, it would be possible to fit the spans by free erection on either side of each pier. The junction of the two sections of a girder would then have to be made in the center of the central span; but whatever care is taken in carrying out this operation, it would leave serious doubts as to the continuity of the girders, such as is assumed in the calculations.

It is by far preferable to commence the mounting in the center of the central span with the aid of auxiliary and removable piers interposed between the piers that are to be left standing permanently. In the case of the larger spans two piers might be arranged, as shown in Fig. 14.

These piers are formed of two columns, each 51 m. high, and 6 m. in external diameter, braced together in a transverse direction, and resting upon a caisson, the form of which in horizontal section is that of a rectangle terminating in a semicircle, so that it should oppose the least possible resistance to the currents. At the top the caisson is 35 m. long and 10 m. wide, and at the base 60 m. long and 5 m. wide. Its height is 65 m. for the maximum depths.

The two piers here considered are so situated that there is a distance of 80 m. between their axes, and they are connected by a superstructure forming a platform 100 m. long by 35 m. wide. It is on this platform that the fitting up of the different parts of the bridge will be effected, just as if it was in an ordinary work yard on land, whereupon the construction of it will be continued, by means of free erection, until on either side the permanent pier is reached, which will then have to be completed, so as to be able to receive the girders.

When once the span is set down upon the piers, the mounting operation can be continued with the assistance of the auxiliary piers. The superstructure can then be removed as well as the columns, and both can be used together, with the caissons, in the fitting in place of the next span. Each caisson being of dimensions comparable to those of the caissons provided for in the case of the brickwork surrounding the columns, it will be possible to set it afloat and ground it, after being provided with the compartments necessary to receiving the ballast of sand. Its cubical volume being about 51,000 cubic meters, it will be necessary to fill a little over one-half of it with sand to make it ground. With the caisson in position, it may still be found, even after the same be loaded with the columns, the superstructure, and the portions of the bridge then in course of completion, that infiltration should take place at its base which would give a thrust equivalent to 43,500 tons.

This being so, a ballast of about 8,000 cubic meters of sand will have to be added, in order to insure the stability of the whole under the action of wind at the time that the bridge girders are about to be placed upon the piers intended to support them. For the fitting up of the intermediate spans two auxiliary piers seem necessary. As to the small spans, where the piers of the bridge are 100 m. apart, one single auxiliary pier will be sufficient, if it be connected with the permanent pier by a platform.

VIII.—ESTIMATES OF WEIGHT.

The following weights have been obtained by adding to those found by calculations 18 per cent., to provide for additional pieces that will be employed in fitting and riveting.

Taking all parts together, the limit of stress is assumed to be 12 kilos. per sectional square millimeter, the rivet bolts not being subtracted. This limit, however, may be considered as a very high one, for it has never been reached hitherto in all the steel structures that have been built; but, nevertheless, after carefully examining the conditions involved in the question, it will be found that the assumption of such a limit is not unjustified.

In the present case the permanent load represents eight-elevenths of the total load. From the formulas deducted from the experiments of Wohler, it appears that the limit of stress of 12 kilos. offers the same guarantees of safety as a limit of 10·5 kilos. in the case where the permanent load and the additional load have equal influences.

In the case of such pieces as the longitudinals under the rails and the beams, where the additional load greatly exceeds the permanent load, it may be said that the addition of 18 per cent. is certainly excessive—in fact, that it surpasses any figure suggested by a lengthy experience.

* A paper read at the meeting of the Iron and Steel Institute, Paris, 1889.—*From the Engineer.*

Even as regards the other parts of the bridge, this figure may be regarded as exaggerated, owing to the use of sheet iron and section irons that can attain 12 m. in length, which would notably reduce the importance of the fittings.

It must be added that in calculating these pieces, very liberal allowance has been made for any unforeseen excess of weight, since, instead of calculating their real length, the distance between their axes has been taken into account.

To simplify calculations, the same coefficient—12 kilos.—has been admitted as applying to all the members of the bridge.

In a final project, however, it will be necessary to examine whether it is not more rational to attribute to each piece a coefficient of resistance varying with the size and the direction of the stress to which that particular part is subjected. (We reproduce only the figures relating to the large spans.)

Central span.						Cantilever arms.					
Lower members.		Upper members.		Bars.		Lower members.		Upper members.		Bars.	
	Tons.		Tons.		Tons.		Tons.		Tons.		Tons.
A_1	76,093	A'	45.088	*a*	22,839	D_1	137,231	D'	172,280	*g*	125,527
A_2	78,010	B'	96,293	*b*	28,658	D_2	127,419	E'	106,670	*h*	108,914
B_1	92,230	C'	121,117	*c*	59,267	E_1	77,251	F'	59,976	*i*	64,494
B_2	98,059			*d*	74,950	E_2	70,487	G'	33,340	*j*	56,578
C_1	126,814			*e*	122,537	F_1	40,198	H'	16,320	*k*	30,756
C_2	136,820			*f*	166,146	F_2	35,972	I	4,528	*l*	28,261
						G_1	18,702			*m*	14,338
						G_2	15,950			*n*	14,706
						H_1	5,993			*o*	7,167
						H_2	6,913			*p*	9,485
						I	3,833			*q*	5,238
	608,026		262,498		474,397		530,948		398,114		465,464

Names of pieces.	One central span of 300 meters.	Two overhanging pieces of 187·5 meters each.
	Tons.	Tons.
Main girders	5,379,681	5,594,104
Secondary bars of the main girders	67,336	55,632
Foot plates, rails, footways, and bracings of sleepers	411,732	501,560
Longitudinals under rails	335,040	380,680
Beams	106,824	97,002
Lower bracing	270,468	431.144
Cross bracing	45,584	41.006
	6,616,668	7,101,128
Sum total	13,717,796	

Lower chords.		Upper chords.		Bars.	
	Tons.		Tons.		Tons.
J	2,353	J'	3,827	*y*	9,968
K_1	2,880	K'	7,409	*r*	2,715
K_2	2,307	L'	11,911	*s*	2,839
L_1	3,977			*t*	2,464
L_2	4,375			*u*	1,158
M_1	5,812			*v*	1,857
				w	571
	21,724		23,147		21,572

	Tons.
Main girders	265,772
Secondary bars of principal girders	11,790
Plates, rails, footways, bracings of sleepers	162,584
Longitudinals under rails	102,720
Beams	24,114
Lower bracing	16,864
Upper bracing	13,488
Cross bracing	8,862
Total	606,194

(3) *Two Metal Piers.*

Interior framing of lower numbers of floor girders	60
Supporting contrivance	764
Metal columns	2,268
Bracing of columns	332
Anchor tubes	240
Anchor bolts	360
Total	4,024

Summary.

Metal flooring (1° + 2°)	14,324
Piers (3°)	4,024
Total	18,348

Weight per meter of column : $\frac{18.348}{800}$ = about 23 tons.

Treating the other spans in the same way, the authors arrive at the following summary :

General Summary.

No. of spans for the whole of the bridge.	Description of spans.	Units.		Totals.	
		Lgths.	Wghts.	Lgths.	Wghts.
		Meters.	Tons.	Meters.	Tons.
32	Spans of 300 and 500 m.	800	18,348	25,600	587,136
13	" of 200 and 350 m.	550	8,945	7,150	116,285
14	" of 100 and 250 m.	350	4,846	4,900	67,844
	Totals for the whole bridge			37,658	771,265

Average weight per linear meter of bridge : $\frac{771,265}{37,650}$ = 20·5 tons.

HIGHWAY IMPROVEMENT.*

MR. PRESIDENT AND GENTLEMEN : Macaulay says that of all inventions, the alphabet and printing press alone expected, those inventions which abridge distance have done most for the civilization of our species.

A nation, or an age of civilization, is perhaps more easily judged and understood by the character and extensiveness of its roads than by any other symbol of progress.

Intercourse between communities, and the development of commercial life, have afforded the necessity for regularly adopted routes of travel and more or less systematically prepared roadways, from the time before the building of those famous highways between ancient Memphis and Babylon, over which the untold wealth of the valleys of the Euphrates and the Nile found means of exchange, where the magnificent cities of Nineveh, Damascus, and Tyre, the earliest great commercial centers, sprang up, and over which the splendid armies of Xerxes and Alexander the Great passed in all the pride and glory of those early days.

The roadways of which the earliest traces appear were well constructed, as is evident from the remains found, but they were limited in number, laid out generally in direct lines, and had the advantage in their construction of all the resources of the rich and powerful nations which built them.

As the world has grown older, and civilization has spread and ripened, intercourse has increased, commerce has pressed out its foot in every direction, from every center, multiplying and ramifying its paths in as bewildering an extent as the threads of the spider's web.

Various necessities and circumstances have governed the building and maintenance of roads of different times and people.

The old countries, where war has been a constant factor, have looked after them as a matter of national policy and military necessity, and have the result in the finest and most durable ways in the world.

The old military roads of the Roman empire constituted a system the superior of which the world has never seen, in its scope and the thoroughness with which it was perfected in all directions. The old "world conquerors" were good road builders for their day, though Blake crushers and the respective merits of Trinidad and rock asphalts and Wheeling fire brick were matters of which they never dreamed; and those of us who have had occasion to form intimate acquaintance with American country roads in spring have more than once found ourselves in positions to heartily wish that some of the rural road makers, who worked out their taxes by plowing up the mud from the ditches and plastering it over the middle of the highways, had had some good experience in the road gangs under the centurions of Julius Cæsar's army.

An eminent writer says: "The road is that physical sign or symbol by which you will best understand any age or people. If they have no roads, they are savages, for the road is the creation of man, and the type of civilized society."

The Romans were, without doubt, the best road builders in the ancient world. Their good highways were one of the causes of their superiority in progress and civilization. When they conquered a province, they annexed it by good roads, which brought them in easy communication with the great cities of the Roman world. When their territory was so large that a hundred millions of people acknowledged their military and political power, their capital city was the center of such a network of highways that it was then a common saying, "All roads lead to Rome."

The best roads in the world to-day are those of England, France, and Germany, the excellence of which is due to the fact that those countries were the first to awaken from the long sleep of the dark ages, and the growing rivalry between them necessitated attention to their roads, for the proper prosecution of both their military and their mercantile interests. In each country they early came under the national supervision, the results of which are seen in the most splendid highways in existence, costing the least to maintain, and in every way the most satisfactory and economical for those who use them.

Up to the advent of railroads, most of the settlements in this country were along our water fronts and on our sea coasts, lakes, and rivers. The invention of steam, and the development of the railroad, seem to have taken all our energies and resources, to the neglect of our roads and highways, and now that we have more miles of railway than the whole of the eastern hemisphere, and about all that we can make to pay, at present, we can well afford to turn our attention to the matter of highways, in which everybody should be interested, for all have to use them, rich and poor alike, those that ride and those that walk.

No country has a greater road mileage, in proportion to the population, than the United States, but while, with characteristic American push and hurry, the most extensive means of communication and intercourse have been provided, we have suffered the consequence of a lack of any general system of public policy covering the location, construction, and maintenance of ways.

In many a case, where one's way leads him through the old farming regions of New England and the Middle States, he may take occasion to do anything but bless the memory of the frugal early settlers who, when the necessities of the case seemed to demand that a road be established for the convenience of public travel, each contributed a way across his farm, lying perhaps over the worst hill and through the sandiest, or the rockiest, or the wettest land, with a view rather to the economy of his best pastures than the saving, in the years to come, of the time and strength of the traveler obliged to use it.

American roads are far below the average; they certainly are among the worst in the civilized world, and always have been—largely as a result of permitting local circumstances to determine the location, with little or no regard for any general system, and haste, and waste, and ignorance in building.

Old post roads and turnpikes, in times no further back than the war, afforded the only comfortable travel to be had in many parts of the country; nor could the general badness of the roads, by any means, be attributed to a lack of the proper materials for their construction. Indeed, it often happens that we find them the worst where natural resources are the most abundant, and the better roads are frequently found where the natural conditions were so bad that the ordinary crude and wasteful expenditures were out of the question.

Fifty years ago, there was some excuse for bad roads, for our country was poor. Now it is rich, there is no excuse.

A good road is always to be desired, and is a source of comfort and convenience to every traveler.

Good roads attract population, as well as good schools and churches. Good roads improve the value of property, so that it is said a farm lying five miles from market connected by a bad road is of less value than an equally good farm lying ten miles away from market connected by a good road.

A larger load can be drawn by one horse over a good road than by two over a bad one.

Good roads encourage the greater exchange of products and commodities between one section and another.

Good roads are of great value to railroads as feeders.

Various movements, already under way, in the direction of road improvements, must have and already are having their effect, in bringing about a material raising of the average quality. The governors of several States have made special and important references to it in their annual messages, and in several States bills have been presented having in view the betterment of State highways, by regularly organized systems of work, to be carried out under the supervision of departments provided by the State.

In Pennsylvania a general tax levy of seven and one-half mills has been ordered by legislature, for road improvements. The forces working to bring about such results as this are powerful, and increasing every day.

The high point to be aimed at is the recognition of the importance of the whole situation by the national government, and the establishment by Congress of a national system.

The following outline may suggest some idea of a scheme in the right direction, which might be elaborated by some one better qualified and having more time than I have at my command.

A commissioner of highways might be provided for, in the Agricultural Department, with a corps of consulting engineers, and suitable appropriations made, for the prosecution of a general supervising work.

Under the charge of this commission, full systems of maps should be prepared, based largely perhaps upon the working of the State and county boards, showing more or less completely, as circumstances would permit, the highways of the country.

For co-operation with this central bureau and the prosecution of the work in the most thorough and practical way, each State should have its highway commissioner, charged with the highest interests of the State in the way of maintaining its system of roads under the most approved methods and for the general public welfare. Then the best practical results could probably be attained, by the division of the State into highway districts, consisting of counties, or perhaps townships, each of which should have its overseer in full charge of the opening and construction of new roads in his district and the proper maintenance of all, responsible for the expenditure of the regular appropriations for these purposes. These districts could then be divided into smaller ones under sub-overseers.

The importance and the value to any country, any section, and every citizen, from the highest to the lowest, whether tax-payers or tramps, of well constructed and properly maintained roads is not easily estimated, but clearly it is greater than that of many affairs which are continually receiving the time and attention of the people in their homes, counting rooms, public meetings and legislative halls.

It is a matter to be considered side by side with our splendid and always improving system of public education, the assessment of our tariff duties, or the appropriations regularly made for river and harbor improvements.

But the question of the most particular interest, to-day, to you and to me, as manufacturers and merchants, in this whole question of good and bad roads is, *what is the effect on our business?* Now it may be possible that there are those who will think they see an advantage for the carriage builder in poor roads, where in traveling over hills that might easily be avoided, going ten miles to make five as the crow flies, pulling through mud and sand that should be gravel and jolting over rocks that might be macadam, the vehicles of the unfortunate owners would go to pieces in one half the time they ought to stand under favorable circumstances, and necessitate the purchase of new ones, to the advantage and profit of the manufacturer.

But a man who entertains such an idea would waste no time in killing his goose to secure the last golden egg.

It must be clear to any man with the most ordinary business instincts that good roads mean thrift, liberality, and wealth. They mean good farms and good value to real estate. They mean that the farmer enjoying their use will save time going over them, will save wear and tear, not only on his wagons, but on his teams, will be a richer man on account of them, and have the more money to buy your carriages, running into higher value (while his sons and daughters can have their bicycles and tricycles at less expense), and his example must be followed by his neighbors.

Now you are honest manufacturers, and have no desire to have your vehicles wear out quickly, that they may be sooner replaced, but you believe, I doubt not, that the better the vehicle and the longer it lasts, the better business and profit will come to you.

Good roads mean for you and for me better business. Good roads encourage riding and driving, and the sale of our vehicles, while bad roads mean less business for you and for me, for where the roads are bad the traffic must of necessity be much less.

As a nation we are remarkably patient and an easy-going people, considering the enterprise and business activity for which we are noted the world over, and rather too apt to fall into the way of doing things as a matter of course. As a result of this, very strenuous and continuous efforts are frequently necessary to bring about the farthest reaching and most desirable reforms. From a business point of view, we cannot afford to neglect any opportunity to help along the present movement.

As an instance of what is being done, see the work of the League of American Wheelmen in the appointment of its highway committees, the issuing of road books and maps, the pressing forward of legislative bills, and lately in the publication of a comprehensive little manual on the making and care of

* An address by Colonel Albert A. Pope, of Boston, before the Carriage Builders' National Association, at Syracuse, N. Y., October 17, 1889.

good roads, a copy of which I shall be glad to have forwarded to any one who may care to send me his address.

Work of this sort can well and profitably be undertaken by the Carriage Builders' National Association. With all the great resources at your command you cannot afford not to divert a small percentage each year, beginning right now, toward helping along in the good work, and it impresses itself upon me most strongly, as a part of your most urgent duty toward yourselves, to appoint at once, if you have not already done so, your committee on highways, clothing them with power to do some practical work, and giving them, under reasonable limitations, at least, the approach to your treasury. A moderate amount of money judiciously expended in educating the people up to their needs and best interests, in showing them how their roads are, and how they ought to be, and how to go to work to make them so, could not be put out at better interest. I am credibly informed that within one hundred miles of this building the capital invested in the carriage industry amounts to seven million dollars; and the interest which I informally represent to you is a true branch of this vast industry. The manufacture and sale of carriages to be drawn by horses and the manufacture of carriages to be impelled by the rider is essentially one and the same. The character of the motive power cannot of course change the character of the vehicle. We, who manufacture bicycles, feel that we have a right to fraternization with you. We seek fellowship with you in your efforts to improve the traveling vehicles of the country and the roadways by the improvement in which our interests as manufacturers and the people's prosperity and happiness are to be enlarged.

The bicycle interest is young in years, but it has already become a large one. As an industry it ranks among the fine arts, while the magnitude of the business and the number of the vehicles made and sold yearly would, we fancy, be a matter of surprise to some of you and of amazement to the public at large.

I need not say to this convention that we who construct these delicate carriages propelled by human power are intensely interested in the improvement of the country's roadways, even as you who manufacture wagons and carriages of the lighter and more elegant sort. It is true that in a certain sense the bicycler is not so dependent as the man who drives his carriage or road wagon on the quality of the roadway, for he can pick his way with much greater facility. Wherever there is a hand's width of level way there he can easily pass. He can turn from left to right with wonderful ease and quickness. He can even take to the sidewalk and so escape many ill-conditioned places which the driver of carriages cannot. Nevertheless, I feel that our interests and yours in good roadways are equal and identical, and I am here to pledge our heartiest co-operation with you in any practical measure looking to the improvement of the roadways of the country.

The history of carriage building and the history of the development of this country alike confirm the truth which I have tried to impress, namely, that improvement in roads leads to and precedes the use of better and higher grade vehicles, and especially induces the use of pleasure carriages.

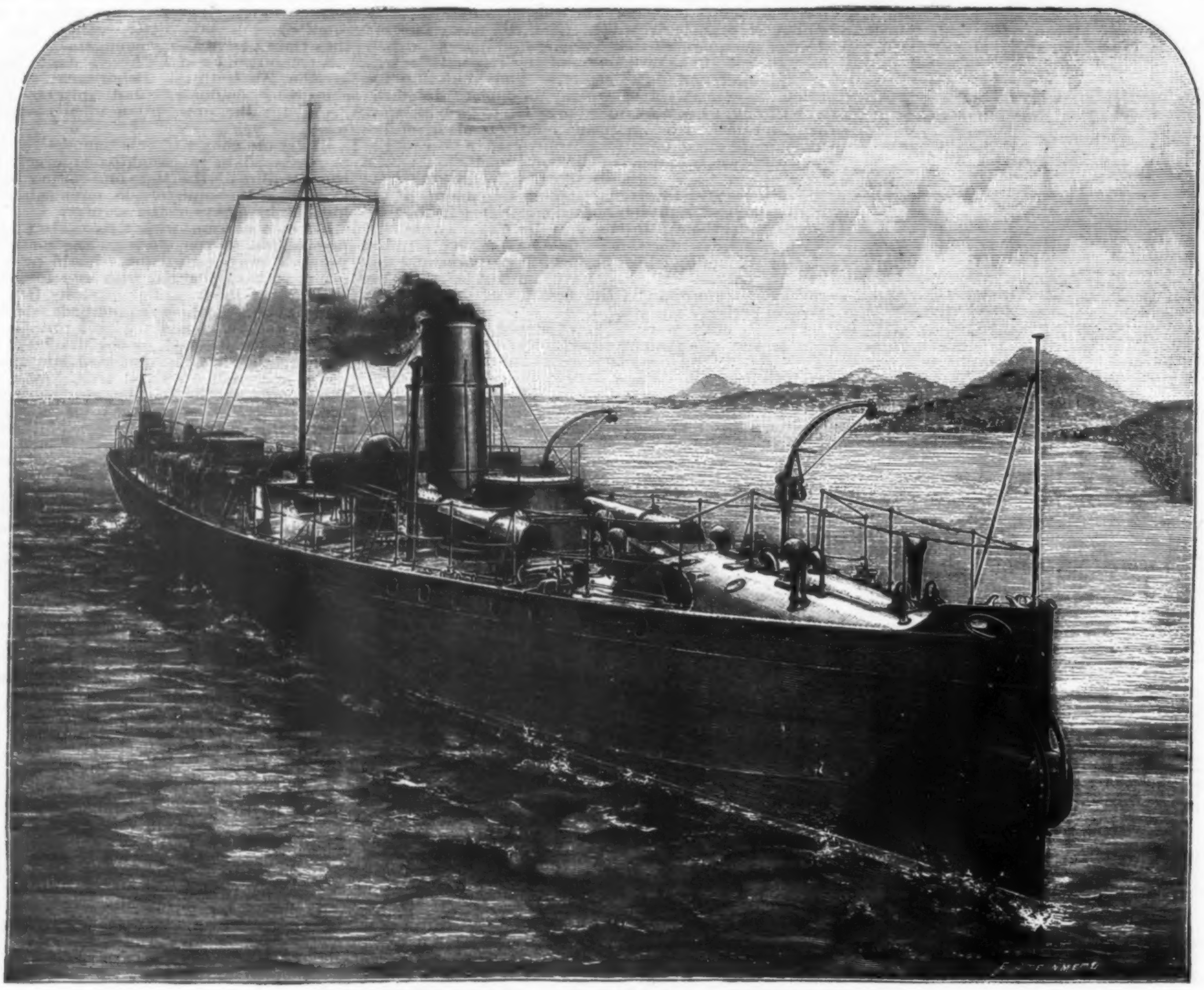
It does not need argument or illustration to persuade you that more roads mean more carriages. Where now go the saddle horse and the mule van in wide regions of this country, ought to be seen the carriage and the bicycle. If local communities and the general public ought to be interested in this subject, how much more should this association, every member of which not only has this same interest, but a special commercial inducement in the result!

I hope to live to see the time when all over our land our cities, towns, and villages shall be connected by as good roads as can be found in the civilized world, and if we shall have been instrumental in bringing about this result, then indeed shall our children have cause to bless us.

NEW TORPEDO BOAT FOR INDIA.

A FIRST-CLASS torpedo boat was a short time ago handed over to the Indian government by Messrs. Hanna, Donald & Wilson, who designed and built her in their establishment at Paisley on the River Cart, a tributary of the Clyde. We give an illustration of this craft. The dimensions of the boat are as follows:

	Feet.
Length over all	130
Beam	14
Depth (moulded)	8



NEW TORPEDO BOAT FOR INDIA.

She is a fine model, floaty a little, and perhaps not quite so keenly cut as some other torpedo boats. Her forefoot is cut away. When fully rigged and equipped with guns, and having coal supply and crew on board, the freeboard is 3 ft. 3 in. She is built of steel of varied thicknesses, but generally speaking, usually thin; and the whole of it is galvanized. Internally it is coated with a composition and covered with ground cork, which not only prevents dampness, but gives to the walls of the saloon a more comfortable appearance than they would otherwise have.

The hull is divided into fourteen water-tight compartments by transverse bulkheads, and in the larger of these compartments there are powerful ejectors for keeping the ship dry and in floating trim. At the bow there is, as the illustration shows, a torpedo tube, placed under the deck and projecting through the stem, with a water-tight door. The next compartment aft is taken up by the "quarters" for the crew. The forward conning tower occupies one of the spaces, and here it may be said that from each of the two conning towers, there being another aft, the vessel may be completely controlled, there being engine telegraphs and connections with the steam and hand steering gear. There is placed in the galley a combined dynamo and engine for illuminating a powerful search light to be fitted on the deck. In the after compartments are fitted the cabin for the officers, magazines, etc., steering gear, and a conning tower.

The propelling machinery of the vessel consists of a set of triple-expansion engines. The power developed is one thousand indicated horse power. For the sake of economizing space, as well as for other reasons, Joy's valve gear is fitted to each of the cylinders. All the auxiliary engines are separately worked. Two sets of Brotherhood's patent compressing engines are provided, a combined centrifugal pump for the condenser and for pumping the engine and stokehold compartments, etc.

One of Kirkaldy's condensers is placed in the engine room. The condensing tubes are of brass, ¾ in. in diameter, and the total surface is 900 square feet. The tank for storing water is of galvanized steel, and is placed along one of the sides of the engine room, being formed to make a seat for the engineers. The engine compartment is covered with a water-tight heavy steel covering with thick glass ports. The boiler is separated from the engines by a transverse bulkhead with a water-tight door. It is of the locomotive type. The length is 15 ft. and the diameter 6 ft. The firebox is made of copper with ordinary bars. The grate surface is 35 feet, and the heating surface 1,200 square feet, the tubes being of brass and 2 in. in diameter. The boiler works to a pressure of 170 lb. to the square inch, and forced draught on the closed stokehold system is adopted. The fan, which was designed and made by the builders, is 4 ft. in diameter, and makes from 600 to 700 revolutions per minute. Across the front of the boiler and along each side are ranged the coal bunkers to afford protection. The coal-carrying capacity is 30 tons, which would take the boat 1,500 knots at a sea speed of 9 knots per hour. On her voyage to Calcutta she steamed from Aden to Colombo with this quantity on board.

The propeller is of steel and has two blades. The diameter is 6 ft., and the pitch 9 ft. 6 in. The rudder is on the balance principle. Both hand and steam steering gear is provided; the latter is of the Pefer type. The gearing is fixed to the bulkhead in the engine room, and may be controlled from the deck or either conning tower.

As will be seen from the view of the craft given, there are fitted at each conning tower two torpedo tubes, 15 in. in diameter, revolving on trunnion wheels round the tower, so that the torpedoes can be fired on either side. Provision has been made for Nordenfelt and 3 pounder quick-firing guns; but the number of these has not yet been determined. Forward there is a windlass and anchor gear. Water-tight scuttles are fitted to each compartment. The deck is constructed of steel.

The vessel before leaving the Clyde was carefully tested, both as to maneuvering and steaming capabilities, with satisfactory results. The speed attained was considerably over 21 knots.—*Engineering.*

ENGLISH ENGINEERING.

ONE of the American engineers who took the recent trip to Europe, in speaking of the Mersey tunnel, which connects Liverpool and Birkenhead, says: "It is quite admirable as a piece of engineering, and very convenient for the two cities. If England had four cities like New York, Brooklyn, Jersey City, and Hoboken in such close proximity as we have, she would have had them connected by tunnels long ago. In great works of civil engineering, especially for municipal convenience, the English are ahead of us, not from superior ability as engineers, for we can build just as

fine works as they can, but there the civic authorities are more progressive and far-sighted than here; they have more money possibly, or they are more willing to tax the public for improvements for the public benefit; but they do seem to give more employment to the civil engineers than we do.

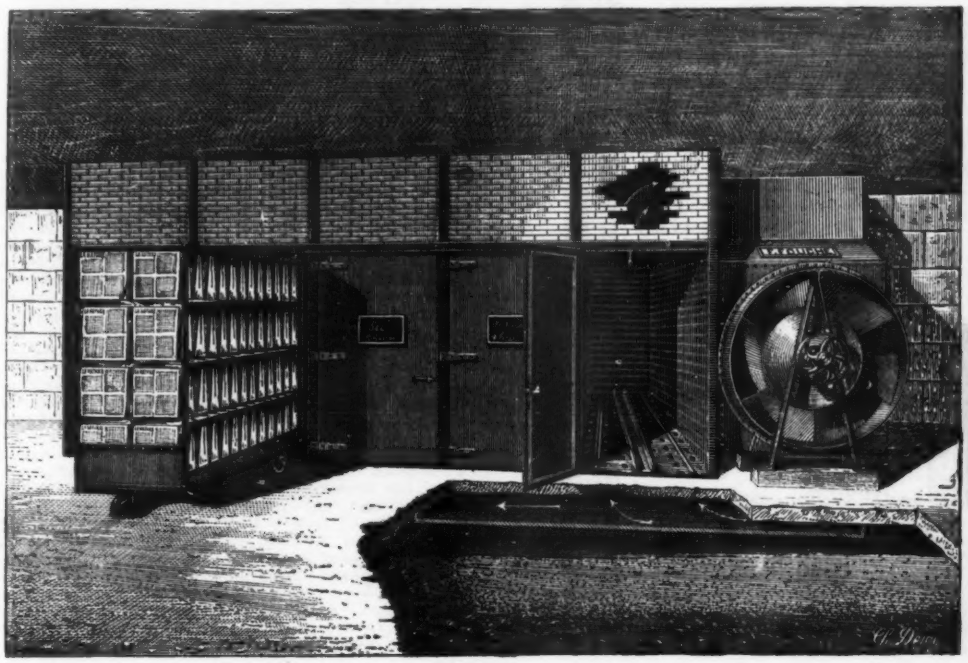
AERO-CONDENSER FOR DRYING PAPER.

THE annexed engraving represents an arrangement devised by Mr. Fouche for the printing offices of Mr. Masson, the well known publisher of Paris. It is designed for drying paper fresh from the printing press, the heat being furnished by the waste steam of the establishment.

The air is forced by a blower against a system of iron tubes through which flows the waste steam from the engine. It becomes heated, and, through a conduit under the floor, is distributed through the four driers, which it traverses from bottom to top, and then escapes through a conduit above.

The paper is placed in packages of twenty-five sheets upon wooden rods carried by three-wheeled carriages which just fit into the drying chambers. The air acts at a temperature of 40° C. and effects the drying in two hours.

The arrangement not only provides hot air for the drying, but also for heating the entire establishment. Since its installation in 1882, it has required no repairs, and the amount of fuel used for motive power, drying and heating does not exceed 440 pounds a day.—*Le Genie Civil.*



IMPROVED AERO-CONDENSER.

INSTRUMENTS FOR DRAWING CURVES.

By Professor C. W. MACCORD, Sc.D.

NO. VII.—THE WITCH OF AGNESI.

IN Fig. 1, let C be the center of a circle, and A C O the vertical diameter; draw A M tangent to the circle at A, and through O draw any line O D at pleasure, cutting A M in D, and the circumference in B; next draw a vertical line through D, and a horizontal line through B, intersecting in P; then P is a point on the curve called the *Witch*.

It will be apparent that if O be regarded as a fixed center about which the line O D revolves, we may also consider C as the fixed center about which the crank C B revolves; and regarding this crank as the driver, its extremity B will cause O D to turn with an angular velocity half as great as that of the crank, because the angle A C B is double the angle A O B. Also, the horizontal through B will be carried across the circle in a vertical direction with a perfect harmonic motion: but since the angle A C E is always equal to the angle A C B, this harmonic motion of the horizontal line, in which P is always to be found, might also be secured by the rotation of the crank in the opposite direction with the same angular velocity, the motion of O D remaining unchanged, and being produced if desired by any other means than that above suggested.

Now, having drawn O D′ and determined the point P′ on the curve as above explained, produce D′ P′ to cut the horizontal line O N, in the point O′, bisect D′ O′ in C′, about which point describe a circle upon O′ D′ as a diameter, cutting O D′ in G, and B′ P′ in I; draw G C′ and produce it to cut the circumference in H, also draw the chord G I and the radius I C′.

The triangles O C B′, G C′ D′, are isosceles, and, by reason of the parallels O A, O′ D′, the angles C O B′, G D′ C′, are equal, whence G C′ D′, or its equal O′ C′ H, is equal to O C B′, therefore the point H lies on the horizontal B′ I P′, and since the vertical C′ O′ bisects the chord I H, the horizontal C′ C bisects the supplementary chord G I.

We may, then, suppose the original circle to be translated in the direction C C′, and the line O D′ to be pivoted to a center D′ at the highest point of the circumference, around which it turns as indicated by the arrow *a*, while always passing through the fixed point O. A crank G C′ may also be made to turn around the traveling center C′, at the required rate, by means of the device shown in Fig. 2; its pin G working in a slot whose direction is G D′. This figure also exhibits a means of producing the required harmonic motion of P′. At H erect a vertical line H K, limited by the horizontal diameter, and draw P′ K; this latter line being a diagonal of the rectangle C′ P′ H K, will be parallel and equal to I C′; and moreover, P′ K and C′ H mutually bisect each other, whence C′ L is one half of G C′. If then P′ K be a rigid link pivoted at its extremities to blocks sliding in the vertical and horizontal slots shown, and at its center to the short crank C′ L, the point P′ will move in the vertical line with the exact harmonic motion, while L travels in a circle around the center C′.

From the above elements we can now construct an instrument capable of tracing a limited portion of the Witch; it is apparent that the curve extends to infinity on either side of A O, having O N for an asymptote.

This apparatus is shown in Fig. 3; two bars, A B, are connected by transverse pieces T T, forming a rectangular frame. The pieces T T, and the bar B, rest upon the paper, but A is supported a little distance above it, and being of considerable depth and chamfered on the upper and lower edges, it serves as a guide for the bracket P, at the back of which are formed dovetail grooves to which A is snugly fitted, permitting the bracket to slide, but without rocking, parallel to the paper.

To a lug at the top of this bracket is pivoted the bar K D, in which is a long slot S S, wider below than above. A block *b*, with correspondingly chamfered edges, is fitted to slide freely in this slot, and is pivoted at C to a bridge piece, B′, supported at a suitable height, and secured to the bar B, by two standards. In the lower side of K D, at the end nearest D, is formed a groove, in which slides a block turning freely on the upwardly projecting pin H of the crank H G, for whose shaft G a bearing is provided in a smaller bracket J, formed in one piece with F. The shaft extends below the bearing, and to this extension is secured the shorter crank G I, whose length is half that of H G; its pin I projects downward, and upon it turns the bar

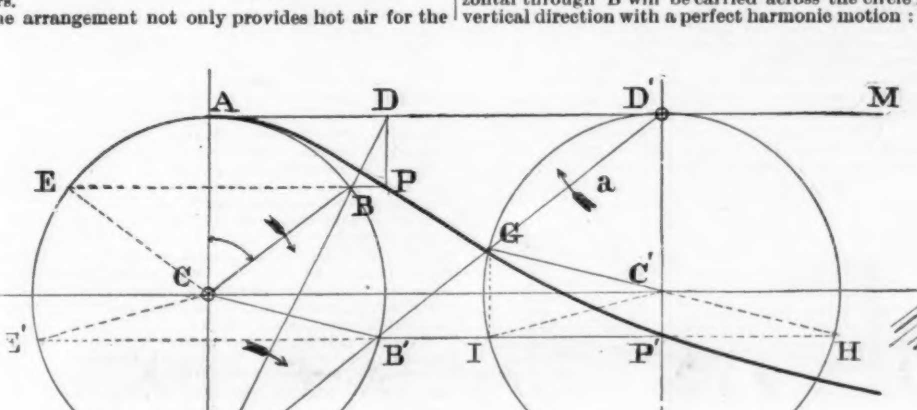


FIG. 1.

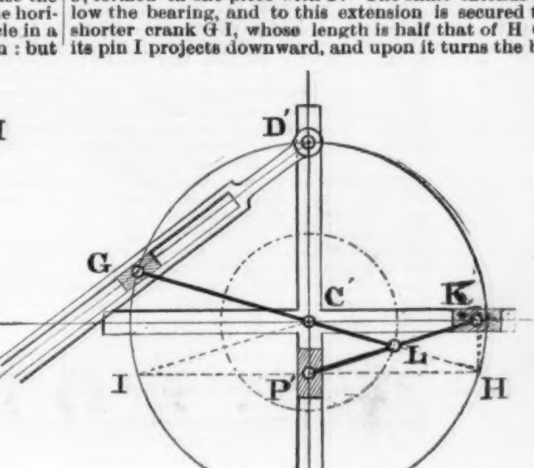
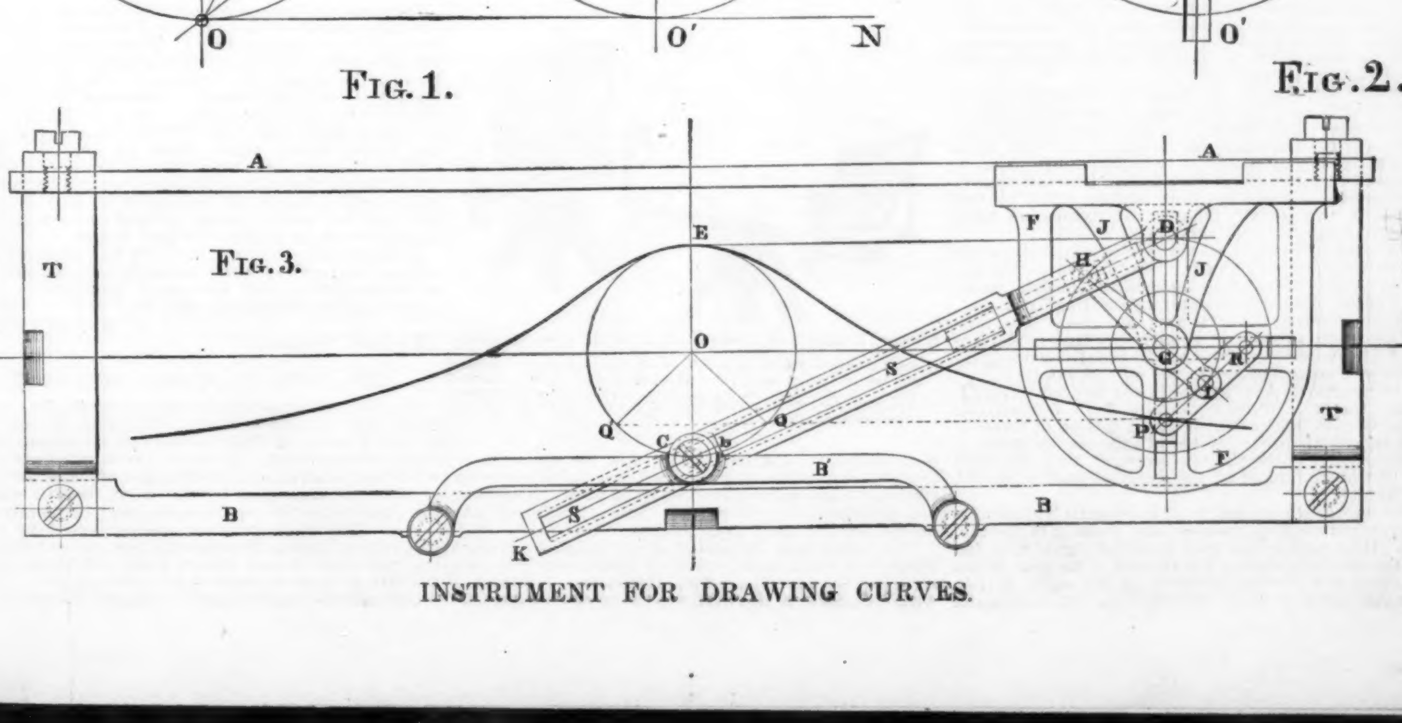


FIG. 2.



INSTRUMENT FOR DRAWING CURVES.

P R, whose length is equal to H G, and P I is equal to I R. This bar or link is pivoted at P and R to blocks which slide in vertical and horizontal slots formed in the bracket F; and the pin at P is extended below the block, and provided with a suitable socket or holder for a pencil, which, as will be readily seen by reference to the preceding figures, will trace the curve shown, as the bracket F is made to slide to the left on the bar A A.

For the benefit of those interested in problems of this nature, it may be observed that the method first explained of locating points in this curve (as, for instance, P' in Fig. 1, by drawing O B' D', a vertical through D' and a horizontal through B')—which is the method given in mathematical treatises—affords no key to the practicable mathematical solution; and the germ out of which the construction grows is the idea of giving the original circle a motion of translation. When this idea is introduced, the point P' would be determined as follows: drawing the circle about any new center C' on the horizontal line through C, draw next the vertical diameter O' D', then O D' cutting the circumference in G: draw the diameter G H, then a horizontal through H cutting O' D' in P' the required point—which is, doubtless, a roundabout way of reaching the result; but it introduces features which are much more available in a mechanical construction. And it may also be mentioned, in illustration of the statement previously made, that a movement or device originally intended for one purpose may prove serviceable for another, that this same idea of translating the circle has been found available, as will be shown in a subsequent article, in dealing with other curves.

THE HELIOGRAPH AND HELIOGRAPHIC SIGNALING.

EXCHANGING signals and communicating important information during the times of war have been in vogue for a very long time. Probably the first allusion made to the practice of signaling dates away back to the early feudal days of Scotland, during those interminable wars between the hostile clans.

Signal fires are inseparable from the Indian wars of America, from King Philip's first sanguinary attack on the colonial settlers down to Captain Jack's last fight made in the lava beds of northern California with his few scattered Modoc braves. Of course, the system of signaling, if such it could be called, was necessarily very crude and primitive; but the Indians, by kindling huge fires on mountain tops, along the hills and in the valleys at certain times, were undoubtedly enabled to convey certain information which was important in conducting their predatory and sporadic modes of wars.

Surviving pioneers of Oregon can recall the signal mountain fires so often seen during the early Indian wars of the North Pacific coast—the famous "Cayuse war," as well as the campaigns of 1854, 1855 and 1856.

During the war of the rebellion the signal corps was one of the chief auxiliaries in conducting the movements of armies and in directing the maneuvers of large bodies of troops during engagements or on the long, weary, forced marches. Without the aid rendered by these signals, the results of many battles would no doubt have been different. But the system as used during the civil war was far from being as complete and perfect as that now in use. Many improvements have been made in the course of subsequent years, and a degree of perfection has been attained.

General Albert J. Meyer, who for many years occupied the position of chief United States signal officer, made many valuable improvements in the system, and to that officer a greater share of credit is due than, perhaps, to any other one man. He was assistant surgeon in the United States army, and stationed for a long time at Fort Hamilton. While there he spent a great deal of time in studying the subject of signaling, and his investigations and experiments resulted in the present excellent system, which has by reason of excellence been universally recognized and adopted.

The whole system of signaling now is based upon and involved in the operation of telegraphy. The key used is what is known as the "Morse alphabet." It is similar to the one now adopted by all telegraphic operators, with the exception of a few letters.

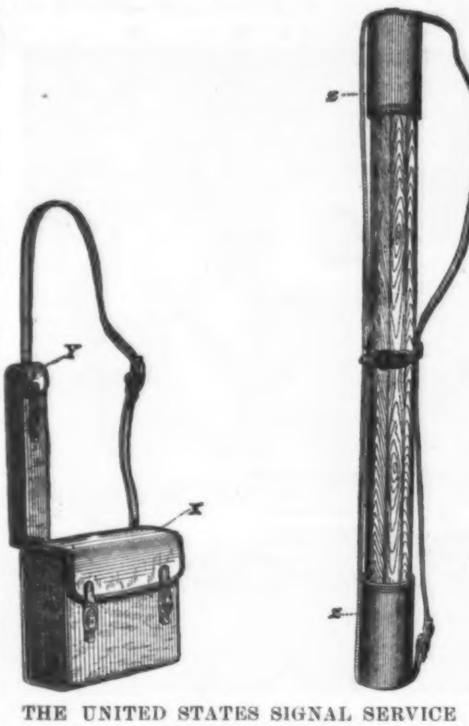
Dots and dashes in the telegraphic alphabet are made to represent letters and numerals. In signaling, certain movements of flags, torches, or flashes which are employed represent these dots and dashes, and thus words are formed and ideas communicated. When properly understood, the entire system is admirable and can easily be mastered. It is simply telegraphing at a distance—greater or less—by visual signs, and not by sound, as is the case with the ordinary telegraphic operator. Three modes are employed in communicating these signals—flags, torches, and that instrument known as the "heliograph."

A heliograph may be described as a simple instrument that is used for signaling by sunlight from a plane mirror. The signals are made by flashing reflections or by obscuring and revealing at will, by a movable screen, an otherwise constant light, which is technically called a "standing flash." The instrument working with a screen has been usually called by the inventor a "heliostat." That giving flashes has been called a heliograph or a heliotrope.

The word heliograph, however, is commonly used to denote both, and will no doubt continue to be the accepted name. A complete instrument consists essentially of two plane mirrors and a "sighting" rod, and, when a "standing flash" is used, a screen. The mirrors are firmly supported, usually on a tripod, and are fitted with vertical and horizontal tangent screws. By means of the tangent screws the mirrors can be turned on their supports so as to face in any desired direction toward the sky. When a movable flash is used, one of the mirrors is so mounted that a motion of three or four degrees about its horizontal axis can be given it independently of the tangent screw, so that the flash can be thrown on and off the receiving station at will, and quickly.

The screen, when used, is on a separate support, in order, when working, to avoid any shaking of the mirrors. Both mirrors are used when the signal man facing the receiving station has the sun in his rear. When the sun is in his front, or nearly at his right or left, only one mirror is used. The sighting rod, as its name implies, is an auxiliary used with the tangent screws, to put and keep the mirrors in such a position that the flash can be cast with certainty on the receiving station.

It is claimed that these "brilliant glimpses" can, under very favorable condition of sun and atmosphere, be seen for a very long distance, varying from 75 to 150 miles. But this requires a great elevation in order to overcome the curvature of the earth's surface. These great distances seem incredible, but those experienced affirm that such is the case. There is one



THE UNITED STATES SIGNAL SERVICE HELIOGRAPH.

X. A sole leather pouch containing one sun mirror and one station mirror inclosed in a wooden box; one screen; one sighting rod; one screw-driver. Y. A smaller pouch, sliding by two loops upon the strap of the larger, containing one mirror bar. Z. A skeleton case containing two tripods.

difficulty, however, in using the heliograph, and that is the *want of distinctness.*

Unless the flashes are produced rather slowly, and the dots and dashes separated very clearly, there is great liability of confusion. Even very expert readers of these signals are liable to make mistakes, and to clearly communicate ideas the operator must observe constant care and "space" his dots and dashes with extreme nicety. The heliograph may be manipulated after night by means of a clever arrangement of two small lamps attached to the instrument. Flashes, long or short, can be produced by delicate adjustment.

The mirrors of a heliograph should be made of glass. Metallic mirrors would be difficult to keep bright in service, and these are open to still more serious objections. It is necessary that the mirrors be as nearly plane as possible. If of metal, they would be liable to become bent or indented. The damage might be so

A, tripod; B, tripod head; C, sun mirror; D, station mirror; E, mirror supports; F, tangent screw for revolving mirror about horizontal axis; G, mirror bar; H, tangent screw with ball bearings for revolving mirror about vertical axis; I, clamp screw for attaching mirror bar to tripod; K, spring for clamping mirrors and sighting rod; L, sighting rod with movable disk; M, screen; N, key for screen; O, screen spring.

slight as not to be apparent and still be sufficient to render it impossible to give a good flash to the receiving station. Glass mirrors are free from these objections, and experience has shown that those of the small size needed are not likely to be broken.

The heliograph, by reason of its infinitely greater range, is a much more valuable instrument for field signaling than the flag. The extreme range of the flag without glasses is not over two miles, and with a telescope having a power of thirty diameters it cannot be read more than 20 miles under the most favorable conditions. The average speed in the transmission of messages by flag is about three words a minute, and the labor of going through the many movements necessary is by no means light. An operator well practiced in the use of the heliograph can send eight words a minute and no manual labor is required. It is more tiresome to receive from the heliograph than the flag or torch, because the concentration of attention required and the strain upon the eyes are greater. The latter difficulty may be much lessened by the use of colored glasses or, better still, of a screen which will cut off the glare of the sky and ground without obstructing any of the light from the distant instrument.

Much public attention has been directed to the heliograph and heliograph signaling in Portland during the past two years, and many practical experiments have been made with the instrument. When the Oregon Alpine Club first made the proposition to the citizens of Portland to illuminate the summit of Mount Hood on the night of July 4, 1887, the subject of heliographic signaling was also included. It was proposed by the hardy and courageous party of climbers, who were to burn red fire on the brow of the hoary old mountain sentinel, to carry along a heliograph, and to flash signals. After emerging from the timber line, and coming out upon the elevated snow fields of the peak, the party proposed to make repeated experiments with the instrument. Arrangements were made with the United States signal officer in Portland (who also was provided with a heliograph) to both receive signals from the ascending party and to flash back responses. The great elevation of the one instrument, it was claimed by one of the projectors, would enable signals to be communicated to and fro for a great distance. On an air line the distance intervening between Portland and Mount Hood is about fifty miles. It was thought that the flashes could easily be seen for that distance under favorable conditions of air and sky.

With all arrangements complete, the party set off for the peak. Unluckily, however, some essential portion of the heliograph was broken in making the first part of the trip, that rendered the instrument practically useless. Though the signal officer in the city kept a constant, vigilant lookout from his lofty tower, bending his earnest gaze on the cold, glittering side and summit of the mountain, no welcome flash rewarded his wearying scrutiny. The real cause of the failure was not known until the return of the party.

Last year, when the proposition to illuminate the summit of Mount Hood was renewed, it was determined to make a thorough test of the heliograph. The scientific features of the proposed experiment had awakened so much interest, and the project had elicited so much public comment, that the success or failure of the signaling was looked forward to with a great degree of curiosity, almost equal to that which attached to the illumination of the peak.

Lieutenant O'Neil, U.S.A., who composed one of the party, took along a fine instrument securely packed against accident or breakage.

The United States signal officer at the Portland station was also supplied with a first-class heliograph. Repeated experiments were made during the time the party was on the mountain, but only a few fugitive flashes were exchanged. There was no intelligible communications. The fact that any flashes were seen at all demonstrated that, under favorable conditions, heliograph signaling was feasible between those remote points of observation.

The reason assigned for the failure was that the weather was cloudy (the party encountering a very fierce storm while midway up the mountain), the atmosphere murky, while the sides and summit of the mountain were constantly enveloped in a hazy, cloud-like mist, through which even the most brilliant and piercing flash from the heliograph could not penetrate. The *extreme difficulty of getting the exact focus of the instrument* no doubt contributed largely toward the failure of the experiment.

With a clear atmosphere and a cloudless sky, it was claimed that heliographic messages could be transmitted by "air line." Small spirit lamps were also carried along, so that the instrument could be used after night, if circumstances favored. But this failed, for the reason that the weather proved boisterous, and the winds extinguished lights.

Experiments have been made with the heliograph between Portland and Vancouver Barracks a number of times. The distance between these places is about nine miles. Flashes have been exchanged and communications transmitted to and fro. The practical experiments have proved very satisfactory and successful.

This year the Oregon Alpine Club propose to illuminate the summits of both Mount Hood and Mount St. Helens on the night of July 4. These peaks are nearly 100 miles apart, and from the summits a magnificent view can be obtained of each other; also of Portland. Each party will take along a heliograph, and the intention is to make repeated experiments. These parties will signal each other, and will also communicate with the United States signal officer in this city. As a party has already been organized to illuminate the summit of Mount Tacoma (or Raineer), which is about 100 miles north of Mount St. Helens, it is very probable that they will carry a heliograph and endeavor to flash signals to various points on Puget Sound.

A widespread feeling of curiosity has been awakened, and the result of these scientific experiments will be watched with great interest by hundreds of thousands of people during the first week of July, 1889.

J. M. BALTIMORE.

Portland, Oregon.

THE NITRATE WORKS OF CHILE.

WE gave sketches, by our special artist, Mr. Melton Prior, who recently visited the Maquinas of Jaz Pampa and Paccha, in Chile, where vast quantities of nitrate are produced. As there are hundreds of these works scattered all over the Pampas of Chile, and most of them are carried on by the aid of British capital, the importance of this industry may be readily conceived. The whole of them are connected by a railway system, having its termini in Iquique and Pisagua, the two ports where nitrate is shipped to Europe at the rate of many millions of tons every year.

Our artist's sketch shows a portion of one of the

nitrate grounds belonging to the Primitiva Company, presided over by Colonel North, and formed for working one of the richest and most productive tracts in the province of Tarapaca. Under the able management of Mr. J. T. Humberstone it is carried out in a systematic fashion, instead of on the old haphazard plan, under which laborers working on their own account contented themselves with picking out the richest spots and passed over the remainder. The slope to be worked having been duly tested as to the presence of caliche by sinking small circular holes at intervals over its surface, the corrector, or head overseer, of the calicheras, acting under the general instructions of the manager, gives orders for the sinking of tiros or blasting shafts, in such places as he deems most suitable, arranging as a rule to work up hill so as to facilitate the disposal of refuse. The tiros are sunk by the barreteros, who take their name from the long pointed bar of iron employed by them in this operation, and who are paid so much per foot according to the depth to which the hole has to be driven and the hardness of the ground penetrated. The hole is little more than a foot in diameter, the loosened earth being removed by means of a kind of ladle attached to a long pole. When the barretero has penetrated through chuca, costra, and caliche, and reached the underlying stratum of cova or soft earth, the services of the destazador come into play. He is a small and slender boy, who slips down to the bottom of the shaft and scoops away the loose earth all round so as to form what is known as the taza or cup. The completed shaft is then taken over by the "particular," who proceeds to charge the taza with the requisite amount of slow-burning gunpowder, to affix a slow match, and to carefully tamp the shaft in such wise that the coming explosion may rather gently lift the surrounding ground than rend a crater in it or send it flying into the air. The fuse is fired, and then follows either a dull, rumbling roar, a slow heave of the ground, and an upward rush of thick brown dust that hangs about in a dense and blinding cloud, signs of a perfectly laid tiro, or the sharper explosion and brisk jet of smoke and dust, mingled with widely scattering masses of costra and caliche, that mark a less accurately calculated charge. The result is now conjointly inspected by the particular and the corrector, and the price per cartload at which the former shall extract and deliver the caliche debated and settled. This varies according to the depth at which the caliche lies, the thickness and quality of the stratum, and the amount of labor required to break it up and free it from adherent costra. The particular and his mates set to work to separate the caliche from the costra and to break the former into lumps about the size of a man's head for loading into the carts. To accomplish this they are sometimes obliged to have recourse to blasting, driving small holes into the larger masses loosened by the first explosion, and charging these with powder; but, as a rule, the work is done as shown in our engraving, by means of bars, hammers and wedges. The task of separation is facilitated by the presence of the underlying stratum of cova, which forms a kind of floor on which the sorting is readily accomplished. The costra and other refuse is thrown backward down hill, and the dressed caliche piled in heaps in readiness for the carts. These are light iron vehicles drawn by mules. In some cases the carts, when loaded, proceed direct to the maquina, where the nitrate is extracted from the caliche, but the more modern system employed at Primitiva and some other leading establishments is to transfer their contents to iron tip cars running on a portable railway. By this plan the outlying fields can be economically and efficiently worked, and their produce speedily transported to the maquina, there to be subjected to processes which will be described in a subsequent account.—*Illustrated London News.*

NITRATE GROUNDS IN THE PROVINCE OF TARAPACA, CHILE—DIGGING OUT THE CALICHE.

HISTORICAL NOTES UPON EXPLOSIVES AND BLASTING.*

By OSCAR GUTTMANN.

GENTLEMEN: In complying with your kind invitation to read a paper upon explosives, I do not think it advisable to repeat the so often mentioned generalities about the manufacture and composition of the different explosives; I hope to have another opportunity of giving my views with regard thereto. But there is another and much neglected matter about explosives with which I propose to deal to-day, and that is the history of explosives and blasting. I made extensive researches in that direction last year, and now give for the first time a short abstract thereof, hoping to be excused if they do not prove to be as interesting and comprehensive as I should wish.

You are aware that the first explosive known was gunpowder, and it may be said that the progress of civilization could not have been so rapid in the semi-barbaric times of the middle ages if gunpowder had not played an important part in the warfare waged during that period. Nevertheless, it appears that the malediction of Sebastian Munster in 1544 will remain true.

He said that "the villain who brought such an obnoxious thing on earth did not deserve that his name should remain in the memory of man."

There is scarcely any nation that did not claim the honor of the invention of gunpowder. I do not intend to go minutely into the results of my researches, which prove that no nation has a special merit in this respect, but I will give you some of them.

Although the Arabians knew of saltpeter in the eighth century, yet only Roger Bacon, in the thirteenth century, mentions that it has the peculiarity to explode in contact with burning materials. In 1311, Yusuf ben Ismail Aldjuny says: "The inhabitants of the Irac use saltpeter to produce fire, which tends to raise and move, it makes the fire easier and quicker to inflame. It is not used elsewhere except as a medicine."

Vassaf, describing in 1313 the different arms, alludes to naphtha vessels, which means Greek fire, but does not speak of gunpowder as such.*

The Chinese people cannot have heard of gunpowder in the early part of the fourteenth century, otherwise they would not have been so frightened when three guns were tried, which the Portuguese of Macao gave them as a present. All that is reported of them relates to the Greek fire.

The allusion to gunpowder which Warren Hastings thought to find in the "Code of Gentoolaw" proves to speak only of fire arrows, so that the Indians are wrongly believed to be the inventors.

In Europe the Italians like to consider Marcus Græcus or Albertus Magnus as the inventor. I do not speak of the latter, because it is proved that he simply copied the former. Marcus Græcus, although he gave a good prescription for gunpowder, yet he prepared his saltpeter from the efflorescence of walls, and the way he refined it, as well as the method of preparing the powder, shows clearly that his gunpowder was utterly incapable of doing any work. Besides, the two weapons which he describes for its use are simply rockets and Chinese crackers.

I am very sorry, also, that the theory which attributes the invention of gunpowder to Roger Bacon, of Oxford, or at least that he knew of it, cannot be supported. As this is questioning the claims of an Englishman, I feel obliged to go closer into the matter. As you know, Roger Bacon died in 1284, and this early date makes it highly improbable that he was the inventor. He was a teacher of medicine, and men of this profession had up to a very late date the privilege and opportunity of occupying themselves with chemistry and mining affairs. In his "Epistolæ," he speaks of certain mixtures, which are capable of making thunder and noise, and by which fire is generated and armies destroyed. A similar passage is in his book named "Opus Majus," but both cannot relate to anything more than a kind of Greek fire. More importance has been attached to a passage in chapter XI. of his "Epistolæ." Certain writers of this century believe that this reads as follows:

"Sed tamen salis petræ *luru mope can ubre* et sulphuris; et sic facies tonitruum et coruscationem, si scias artificium. Videas tamen utrum loquar in ænigmate vel secundum veritatem."

Roger Bacon, like most of the alchemists, concealed an important constituent of his "thunder and destruction" making mixture in an anagram. If the words "luru mope can ubre" really existed, you might read it as "carbonum pulvere," and so we should have the

* Paper read before the Royal Cornwall Polytechnic Society.

* A document in the library of Petersburg, which gives fairly good prescriptions for gunpowder, does not bear any date, and it is very difficult to bring its origin in the beginning of the fourteenth century. Besides that an examination which Professor Vambery and Muller made at my request showed that the weapon described therein was merely a wooden pipe with a touchhole.

three ingredients of gunpowder. But this wording of the anagram does not exist at all. The latest edition of Roger Bacon's "Epistolæ" was printed in 1618, at Hamburg, and there the anagram reads:

"Luru vopo vir can utriet,"

which is not comprehensive at all. But this is also one of those wrong impressions which so often happened in the middle ages. Only two MSS. of Bacon's "Epistolæ" exist in England, one in the British Museum, the other, which is believed to be the very original, in the Bodleian Library at Oxford. The London manuscript (Sloan's MS. 2156) to my surprise contained the anagram as follows:

"Sed tamen saltpetre Kb. Ka. xhopospeadikis et sulphuris 5."

This, of course, is entirely different, more alchemistic, and seems to relate to phosphor. I was not discouraged, but went to Oxford to ascertain what were the important words in the original. But the Oxford manuscript (Digby 164) contained nothing at all of the whole gunpowder composition. It had only the first six chapters, as in the other editions, and ended with a benediction. Neither of these manuscripts is original, but only copies contained in collective volumes, and none of the other Bacon manuscripts at Oxford contain anything of this matter. You see, therefore, that there is no ground for believing that Roger Bacon was the inventor of gunpowder, and even if we believe that in the Hamburg edition there has been no falsification, still Bacon must have thought of a fire mixture, which he occasionally mentioned in a chapter called "How to make the Philosophical Egg." (De modo faciendi ovum philosophorum).

More universal is the belief that the monk Berthold Schwartz, of Freiburg, in Germany, invented gunpowder. There is not a single trustworthy record of such an allegation. There are all sorts of places named where he lived at various times, where he worked, and he appears even under different names. That he invented gunpowder is only said by later writers who could not understand what the contemporaries of Schwartz wrote. All writers living about the time of Schwartz say that he invented the guns, and the only contemporary authentic note in the year book of the town of Ghent, in Holland, dated 1313, says:

"In this year was introduced the use of guns in Germany by a monk."

I feel certain that Berthold Schwartz invented the guns, but not the gunpowder.

After all this, however, the question remains open, "Who invented gunpowder?" I think I may jocularly remark that gunpowder was not invented at all. When Kallinikos, of Heliopolis, in the years of 660 to 667, directed the defense of Constantinople, he invented the so-called Greek fire. Originally, it was naphtha, with which they soon mixed all kinds of inflammables, wax, pitch, sulphur, oil, etc., and his only idea was to burn down the fortified places.

Later on they learnt to throw stones out of catapults, and this naturally led them to throwing vessels of naphtha by their catapults. These were originally hollow stones, later on iron pots containing holes to spread the fire, and as they sometimes cracked, people put cords and iron bands round them. By and by, as the saltpeter was added to the mixture, the rocket arrows were more in use.

The propelling and blasting action of this must have been known by degrees. It is thus out of Greek fire, gradually developed and improved, that I imagine the invention of gunpowder sprang, and not in the Occident, where the highly chivalrous sentiments of the knights, and the superstition of the priests, caused them equally to detest the use of Greek fire, fire arrows, and so forth.

The manufacture of gunpowder was originally conducted in mortars of stone, worked by hand, and later on by millstones. The first powder mill seems to have existed in 1340 at Augsburg. In 1435 Harscher built a stamp mill at Nuremberg, and about this time many others were erected. The first roller mill was built in 1754, by Ferri, in Essone in France, and at the same time Karl Knutberg, in Sweden, erected a kind of incorporating mill.

The composition of gunpowder has almost always been the same until the recent introduction of cocoa powder and smokeless powder. I do not speak of the numerous attempts to replace some of the components, especially the carbon, which, as a rule, were unsuccessful. Braconnot attempted first, in 1833, to treat some materials by nitric acid, and after him Pelouze and Dumas. In 1845 Schonbein, of Bale, and Bottger, of Frankfort, discovered gun cotton simultaneously, which the Austrians first manufactured, and which Sir Frederick Abel so successfully developed. In 1846 Professor Ascanio Sobrero, of Turin, discovered nitroglycerine, and from 1863 to 1866 Alfred Nobel worked until he found the correct method of making dynamite out of nitro-glycerine. The same gradual development, in my opinion, took place with the blasting operations. Mining was more extensively carried on in Germany and Hungary in the seventeenth century, where blasting was first known, than in other parts of Europe. In 1617, Lohneyss said:

"In the soft veins they work with pickaxes, but in the solid ones, with the miner's iron and hammer. In the solid rock on the roof they work with thicker and larger irons; in the very solid rock they work by fire."

It is certain that a passage in Hiob, and the operations of Hannibal, when crossing the Alps, did not relate to anything else than to blasting the rock by means of putting fire underneath it.

In 1622 Elias Montanus tells us of what he calls a breaking implement (pulta), which consisted of a brass ball filled with gunpowder, lined outside with cotton soaked in saltpeter, and dipped into a mixture of pitch and sulphur. The ball was inflamed, the fire propagated through a small hole in it, and thrown into the pit or gallery to drive out the flames produced by the fire blasting. Montanus recommended previously that the mine should be carefully examined, because occasionally the ball breaks at an unexpected moment.

It is easy to assume that this induced him to try the breaking action by introducing similar balls into existing crevices, and, in fact, the first reports about blasting say that originally the gunpowder was used in natural or artificial fissures closed by wooden plugs. The first proper blasting operation was carried out in the Oberbieberstellon in Schemnitz, in Hungary, on February 18, 1627, by Caspar Weindl, a Tyrolese miner. The detailed report was seen by me in the minutes of the Mining Tribunal of Schemnitz of the year 1627, page 37. He then proposed such blasting, and a commission went into the mine to witness it. The report says:

"That it could be well carried out, and would not cause any harm, although sometimes fumes arise, still they disappear in a quarter of an hour, and do not endanger the lives of miners. It also takes away much foul air. But it would not do to shoot often, as it would delay the other miners, who would have to stop work."

Caspar Weindl offered to contract for the working of certain galleries, which were not used, because of the hardness of the rock, and which he worked, in fact, till long afterward, although later on there was much complaint against him.

It is an open question whether Weindl did not originate the blasting operations in Tyrol, as he came from the mines of Count Montecuccoli in that province, who was at this time chief of the Schemnitz government mines. The blasting operations were introduced from Schemnitz to Bohemia and the Hartz, but so slowly that they learnt it only in 1632 at Clausthal, and in 1643 at Freiberg. In 1670, German miners introduced blasting in England, and in 1724 in Sweden. In 1671, an English surgeon, Edward Brown, visited the Continental mines, and he seemed quite astonished at the results witnessed at Herrngrund, in Hungary. He says:

"They showed me a place where the rock was so hard that they could not break it with any of their tools. But they finally found, nevertheless, means to do so with the gunpowder, with which they tightly filled certain long round holes in the rock, and thus blasted it."

According to Prof. Rziha, the first boreholes were made by crown borers of 3 in. width. They were closed by a wooden plug, and the charge put in a leather hose. In 1683, Henning Hutmann invented a kind of machine drill. The clay tamping was introduced in 1685, the firing tubes in 1686, cartridges of paper in 1689, narrower boreholes in 1717, the chisel borer in 1749. Humboldt indicated in 1790 the hollow charging. Harris invented, in 1823, the electric ignition, Bickford, in 1831, the safety fuse, and Brunton and Bartlett, in 1854, the compressed air drilling.

The first large blasting operation was the Malpas tunnel, in 1679, on the channel of Languedoc, in France.

Since this time the development of blasting is known to all of you. You all know that during the last twenty years the use of machine drilling and dynamite has made mining operations advance to a far greater extent than in the previous centuries together, and there is no doubt that the extraordinary development of all branches of industry and the great progress of civilization would, in fact, not have been possible if blasting had not come to be in such extensive use.

A NEW MAGNESIUM FLASH LAMP.

A PECULIAR magnesium flash lamp, invented by Mr. Leisk, was exhibited at the photographic exhibition

at London, last fall, by Marion & Co. In the middle of the large flame is a disk, the rotation of which causes the magnesium powder to fly horizontally into the surrounding flame. The exhibitors claim that by this arrangement, "a very large flame is obtained with only three or four grains of magnesium powder." As the photographic society has Herr Schirm's magnesium lamp also in the exhibition, it would be interesting to spend an evening or more in carefully experimenting with these and other flash lamps, to ascertain the amount of light obtainable by their means with a given weight from one sample of magnesium powder.—*Photo. News.*

PHOTO-ETCHING METHOD FOR MAKING INTAGLIO PLATES.

THE photographic intaglio method ordinarily known as that of Klic is that which has been most extensively used in recent times, and which has generally given the best results; and, moreover, it is a method which any amateur or professional photographer can carry out with such appliances as he is likely to have by him. Indeed, in respect of difficulty of working, it is not much more than the ordinary carbon process. We are, therefore, glad to be able to give reliable details of working, the result of the experience of Mr. A. W. Turner, who has been laboring under the superintendence of Colonel Waterhouse, in the government survey office at Calcutta:

Original Negatives.—These should be unreversed, of good quality, clear, bright, and not too dense. For half tone work a good silver printing negative will generally give good results.

For line work the negative need not be so dense as for photo-lithography, but should be clear and bright, and show the finest lines well. As the process possesses more power of bringing out faint lines than does photo-zincography, it is better as a rule to intensify with pyrogallic acid and silver, rather than with the usual intensifier used for negatives of maps.

In order to secure clear borders on the copper plate, the subject must be masked out on the negative with thin opaque paper or black varnish.

The Transparency.—As a negative image is required on the copper, a reversed transparency must be prepared from the negative, and the simplest way of doing this is by means of the autotype special transparency tissue, developed upon a glass plate by the ordinary autotype pigment printing process.

When subjects have to be enlarged or reduced, the transparencies are best obtained in the camera on gelatine dry plates, but should not be too dense care must also be taken that they are properly reversed, so as to produce a negative image on the copper plate. Looked at from the film side, the image should be reversed just as it is on the negative.

Transparencies can also be obtained with the ordinary autotype standard brown, or other tissues, and this method is particularly suitable for dense negatives, which would take a long time to print and give heavy shadows. Formerly such transparencies were intensified with permanganate of potash, but this is not now found necessary. The transparencies obtained with the special transparency tissue do not require intensifying, even for the line subjects. The exposure under the negative varies, but from twenty to thirty minutes is usually sufficient for half tone subjects, and for line subjects about two minutes in the sun. The transparency should be clear and bright in the lights, and not too dense in the shadows. Held at a short distance from a sheet of white paper, the effect should be very much as desired in the finished print, because the etched images reproduce very closely the characteristics of the transparency. Before being printed from, a mask of the size the printed picture is desired to be should be cut out of thin, semi-transparent paper, and applied on the back of the transparency, so as to provide a "safe edge," to prevent the picture washing up on development.

The Copper Plates.—These should be of the usual thickness as prepared for the use of engravers, and of the best copper, free from holes, flaws, or surface markings, which will assuredly be brought out in the subsequent operations of steel facing, and spoil the effect of the prints. They must be finely polished by rubbing with oil and fine tripoli or flour emery, finishing up with powdered chalk applied with a felt pad. They then have to receive a fine resinous grain, in order to hold the gelatine film during the after process of etching, and also to break up the etched parts of the surface of the copper irregularly, so as to give them the necessary holding power to retain the ink during the printing. We have found that the best substance for this purpose is very finely powdered bitumen, though powdered resin, or a mixture of the two, may also be used. The powdered bitumen is placed in a large box, which is best mounted on pivots, so that it can be turned over to allow the dust to fall from one side to the other; or, if the box is not so mounted, the powder can be blown up with a bellows, or stirred up in any way, so as to produce a cloud of fine dust inside the box. As soon as the coarser particles have subsided, the plate is placed near the bottom of the box, and left for five or ten minutes till a sufficient quantity of the dust has been deposited upon it. A more even grain is obtained for fine work by allowing the dust to settle longer (for two minutes), and repeating the operation two or three times, so as to have a large quantity of very fine dust. For half tone subjects more grain is required than for line, and dark heavy subjects require a stronger grain than light and fine ones. Some experience is necessary to know the proper amount. The loose deposit of bitumen has next to be fixed to the plate. Formerly this was done by exposing the plates for a few seconds to the fumes of benzole or oil of lavender, but Mr. Turner has found it better to do it by heat, the plate being moved about for a short time over a dish containing a little flaming spirit of wine. A heater warmed by gas would, however, be better. It is an advantage to allow the plates to cool spontaneously after this operation. The plates are then ready to receive the negative transfer print from the transparency.

The Negative Pigment Print.—The tissue that has been found to answer best for producing the negative image in gelatine on the copper plate is the Autotype Company's standard brown, No. 100. The tissue is senitized by immersion for one to four minutes, according to the season of the year, in a solution of:

Bichromate of potash	30 parts.
Spirit of wine	150 "
Ammonia	4 "
Water	700 "

It is squeezed down upon a glass plate prepared with French chalk, fanned for about half an hour, placed in a box containing chloride of calcium, and left to dry. It has been found advantageous in the cold weather to leave the tissue for a few days in the chloride of calcium box before use.

The sensitized tissue is cut carefully square to the size required, and laid in its place over the masked transparency in an ordinary printing frame, and exposed to the sun or diffused light for a sufficient time to produce a thin, bright image when developed on the copper plate.

Development.—The copper plate bearing the dust grain is placed in a dish of cold water—in hot weather ice must be used to lower the temperature to at least 60 deg.—and the exposed tissue is immersed in the water, quickly arranged in its place on the copper plate, and withdrawn with the latter as soon as possible, and squeezed down upon it. In the cold weather the tissue should be allowed to soak in the water for about two minutes, and more time can be taken in placing it in position on the plate. The plate with the tissue is left for a time, and then developed in the usual way with warm water. It is better to slightly over-expose and reduce the image, if necessary, by the addition of a small quantity of bicarbonate of soda in the warm water. It is very important that the image should be thoroughly developed, and free from any soluble gelatine. The image being negative, *i. e.*, the lights of the picture being represented by varying thicknesses of gelatine, and the shadows by more or less clear copper, some care is required in development, and this should be conducted slowly with water at a moderate temperature.

After development, the plate is flowed with five per cent. solution of alum, and dried off with spirit of wine. This clears up the shadows and gives a sharper and crisper image than is obtainable by drying spontaneously. It is well to begin with a weak spirit, containing about equal parts of spirit and water, flowing it over the plate from one corner, so as to drive before it the water in the film, together with the insoluble

scum which the spirit forms with any loose soluble gelatine remaining on the surface, and which must be removed with care to avoid markings on the surface. After treatment with stronger spirit till all moisture is removed, the plate may be set aside to dry, but in hot weather it should be finally flooded with a solution of one part of glycerine in twenty parts of spirit of wine, in order to prevent the splitting off of the film on drying.

The plate is now ready for etching. The borders all round the picture, as well as the back of the plate, are painted with a varnish containing twenty per cent. of bitumen dissolved in benzole and left to dry thoroughly.

For etching, solutions of perchloride of iron are used in five different strengths, as shown in the table below:

No.	Strength on Baume's Scale.	Sp. Gr. at 63 Deg. Fah.	Approximate Percentage of Fe_2Cl_6.
I.	45 deg.	1,444	47
II.	40 "	1,375*	41
III.	38 "	1,349	38
IV.	35 "	1,313	35
V.	27 "	1,225	27

A stronger solution at 48 deg. Baume has also been tried, but has no penetrating power through even the thinnest film of gelatine.

The solutions are laid out in a series of flat dishes, into which the plate to be etched is immersed in order, beginning with the strongest (No. I). For line work, as a rule, only Nos. I. and II. are used, the plate being left in No. I. for about two minutes, and then removed to No. II. for another three minutes.

For half tone work, the plate is immersed in No. I., and not left more than one minute after the copper is first attacked; it is then transferred to No. II., and allowed to remain for three or four minutes; then it is passed into No. III., and remains for two minutes; to No. IV. for one minute, and finally to No. V., where it remains for about a minute, till the highest lights are just about to be attacked. The use of the different strengths of perchloride, and the time the plates should be exposed to them, are matters which depend on the nature of the film, the temperature, and the hygrometric state of the weather at the time, and must be learned by practice. A very good guide for the time the plates should remain in each solution is till the action of the perchloride appears to stop; it is then time to transfer it to a weaker solution, or a distinct line will be shown, and result in a hard black and white picture. With the autotype standard brown tissue there is no difficulty in following the progress of the etching in its different stages. The whole operation is usually completed in from five to ten minutes, and should be stopped as soon as it is seen that the high lights are sufficiently bitten. In dry, cold weather it has been found that the gelatine has less resisting power than it has in the warmer months, when there is more moisture in the air. Stronger solutions are, therefore, required as the weather becomes drier and colder.

As soon as the plate is considered sufficiently bitten, it is washed under the tap with a strong current of water, so as to drive out the perchloride of iron as quickly as possible. The gelatine film is then gently removed by rubbing with a muslin or cotton rag. The plate having been dried, the asphaltum varnish is carefully washed off the face and back with benzine. The face of the plate is rubbed over with a little whiting and ammonia, dried, and polished off with a little spirit of wine. The plate should now show a fine, smooth polish on the highest lights, with a gradually increasing depth of biting through the lights to the shadows, and a fine, clear grain throughout.

Obtained as above described, the plates now require no rebiting, and very little touching up beyond oil rubbing and cleaning.

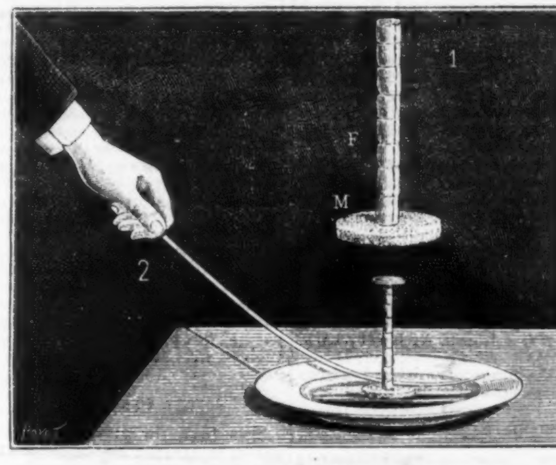
The lettering for half tone plates is usually done by hand, but recently we have adopted a method of lettering the transparencies by printing from type on strips of thin collodionized gelatine, which are cut and fastened in their proper places on the transparency. In order to make the printing more opaque, it is dusted over with red bronze powder, which adheres to the freshly printed letters, and gives them great opacity. Fac-simile names and writing or printing on thin paper can also be inserted by coating the plate with senitive asphaltum solution and exposing it to light under the writing, etc., then developing with turpentine or benzine, and etching with perchloride of iron. Flat and shaded tints can also be inserted on the plates by applying and fixing the dust grain, then stopping out on the plate all but parts required to be tinted, and etching with solution of perchloride of iron at twenty degrees Baume. This satisfactorily takes the place of machine rulings on architectural drawings, and is much less trouble. In skilled hands a variety of effects could be produced by the combination of photo and hand etching.

After lettering and touching up, the plates are carefully steel-faced, and are ready for printing. They require very careful inking and wiping off, and good pressure in printing to avoid streaks of wooliness. The native printers soon learn the work, and, with due care, the proportion of spoiled prints is small—much more so than with collotype.—*Photographic Review.*

A TRICK BASED UPON THE PRINCIPLE OF INERTIA.

ROLL a strip of cloth or flannel into the form of a cylinder, F, that shall be 3¼ inches in length and ⅛ inch in diameter, and then sew the edge of the fabric so that the cylinder may preserve its form. Out of thick swan skin cut a circle, M, 1½ inches in diameter, and to the center of this sew one of the extremities of the cylinder, so that the latter's axis shall be at right angles with the circle. We shall in this way have constructed an apparatus that may be the object of an amusing scientific recreation.

Place the base of the cylinder in the center of a flat dish and put a coin upon the top of the cylinder, which latter, although not stiff, will nevertheless be capable of supporting the money as long as it remains vertical. Now take a light and flexible osier switch and try therewith to expel the cylinder and coin from the dish. When it is stated that there is no need of the coin remaining on the cylinder, but that it may fall alongside of it outside the dish, it might be thought that the problem was one of childish simplicity. Let any one try, and it will be found, on the contrary, that it requires much skill and long practice. Nothing is more easy than to get the cylinder and coin from the center of the dish to its edge by gently sliding the whole along by means of the switch, the flexible cylinder remaining exactly vertical; but, reaching this



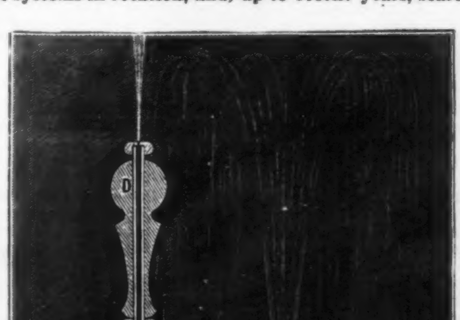
EXPERIMENT IN INERTIA.

point, one has to contend against the slope of the dish's edge. If a quick blow be given, the cylinder will be driven far to the exterior, but, by virtue of the laws of inertia, the coin will fall in the dish, and the experiment will have failed. If, on the contrary, one tries to act upon the cylinder by inclining it toward the exterior, the coin will fall outside, but the extremity of the switch will have followed it, and the cylinder, having merely tilted, will remain upon the edge of the dish. How, then, are we to proceed in order to be successful? The following is the theoretical solution, but this does exclude the practice mentioned above:

Stretch out the hand so that the extremity of the switch shall reach the opposite edge of the dish. Bear upon the extremity of the switch in such a way that the curve thus formed comes exactly in the angle made by the cylinder and its base. By a very slow motion of the wrist, slide the whole to the edge of the dish; then, at the critical moment, continue this lateral motion, but, at the same time, push the switch forward by suddenly stretching out the arm. The object of this motion is to incline the cylinder toward the exterior of the dish, while at the same time leaving the switch near its base. When the coin projects vertically outside of the dish, give a slight, quick blow, which will drive the cylinder to a distance and cause the coin to fall very near the edge, but on the exterior.—*La Nature.*

THE HYDRAULIC TOP.

THE gyroscope and the humming and chameleon tops are the best known applications of the live power of systems in rotation, and, up to recent years, scarcely any others have been known; but mechanical playthings have become the fashion, and inventors have therefore set their wits to work to vary the forms and arrangements of them *ad infinitum.* The locomotive, the waltzers, etc., are the recent varieties most appreciated by children.



THE HYDRAULIC TOP.

Yet the circle in which these toys moved (and never was a figure of speech more appropriate) seemed, upon the whole, somewhat limited, and the new pieces strangely resembled revivals of the old, when Mr. A. Davis brought out the hydraulic or water-jet tops, which every one can now see operating in the English section of the Universal Exposition, and which the accompanying figure represents in section, in order to allow its principle to be understood, and in perspective, in order to show its operation.

The external aspect of the hydraulic top is not very different from that of the humming, chameleon, and other tops. A disk, A, of an alloy of lead, is set in rapid rotation by means of a cord wound round the lower part, as in the majority of tops. When the proper velocity is obtained, the top is placed in a deep dish filled with water to a height of about half an inch. The pivot, B, which is provided at its lower part with a rubber disk, fixes itself firmly in the spot where it has been placed, through the pressure exerted by the weight of the top, and prevents it from wandering over the dish and thus throwing water in every direction and interfering with the regularity of the jet. The lower part of the revolving disk, A, carries a reservoir, R, in which two small vanes, cast in a piece with the disk, carry along the air contained in the reservoir. The centrifugal force thus causes the air to collect in the upper part of the disk, and a vacuum is created that has the effect of sucking up the water contained in the dish. The air in rotation meets the horizontal tube, C, and the air projected against the opening of this tube (kept fixed in space through the pivot, B) enters it, rises through the vertical tube, D, and escapes into the atmosphere through its extremity.

The water sucked up to the bottom of the reservoir, R, follows the same route, escapes from the top, and spreads out in the form of a beautiful wheat sheaf jet, whose height, if the top has been well started, will at first be over three feet. If the jet is very vertical and the nozzle but slightly divergent, all of the water will fall back into the dish and enter into circulation again. If the contrary is the case, a portion will fall outside of the dish, and it will therefore be prudent to place the latter upon a plate of proper size, so that the pleasure of children may not be disturbed by the dissatisfaction of their parents or the protests of servants at being obliged to wipe up the water. It would be possible, however, to change the form of the jet by a proper modification of the nozzle, and, for the divergent wheat sheaf jet, to substitute a simple vertical one, which would almost wholly fall back into the dish. This is a slight improvement, of a purely paternal order, that we permit ourselves to suggest to the inventor.—*La Nature.*

ABOUT BUILDING ASSOCIATIONS.

A CORRESPONDENT "beseeches" the *Household* "to say something" about building associations, "because some such plan of making money is very attractive to women who can put by a certain sum at fixed times," "and because it all reads like Greek to me."

"Me" is not alone in finding the subject a puzzle. There is one authority in the *Ledger* office, however, who has as familiar an acquaintance with the several systems as any one can have, although, in writing about it, "it might never occur to him to imagine and penetrate the depth of ignorance which several questioners have confided to the *Household.* In the beginning, let us say it is only a complicated subject because there are several ways of carrying out the business which building associations do.

It is not difficult to understand any one of them; very easy, in fact, to see that a number of people can agree to save a dollar a month for one share, or several dollars for several shares, putting these dollars together instead of spending the money. They probably, most of them, want to own a house at some future time; the rest of them want to get good interest on their money. Now it is not necessary for all the would-be house owners to wait until each one has *saved* enough to buy his house. As soon as the members altogether have put in enough money to buy one house, somebody can begin.

Up to two years ago the man who wanted most to do this, or felt the readiest to begin, had to bid something for the privilege of getting the money. That was called the premium. (At present, and for two years past, few premiums have been paid, money is so plentiful.) He could then either borrow the entire sum (more than he needed for his house), and pay the premium out of the surplus, or be could borrow only the amount needed to pay for the house. If he had already saved three or four hundred dollars, standing to his credit in the association, he could either let these shares, as they are called, remain to his credit, earning interest for him (partly out of his own payments), or he could draw them out, and so have less interest to pay for the less

sum actually borrowed. He must go on, however, paying in each month the sum he has agreed to pay as a member of the association.

That is the contract by which he is enabled to become a borrower on such convenient terms. He pays this agreed-on quota per month, and he pays also the interest per month on the money he has borrowed. This is kept up until the society has earned, or got together, the money it originally determined to make, when the accounts are closed and the funds divided according to each member's quota or ownership of them. The members who have not borrowed money or bought houses get, of course, the value of their shares in money. The borrowers have had the same amount *advanced* to them, and the closing of the society cancels the debt for that advance. With this money they may have bought houses and have become owners of them with very little anxiety. They have been able to live from the first in them without paying any rent. Instead of that, all their monthly payments have gone toward the purchase, and to pay simple interest on the money advanced to them.

"If the purchaser should default in these payments?" is among the questions poured in upon the *Household* by "T," another correspondent on the subject. "If he is obliged to default *before* he has borrowed any money, what happens?"

If at any time a member is obliged to fall out in payment, the money he has already put in, with interest, is returned to him. It does not draw interest, however, until he has been a member for a year.

"If a man is obliged to stop short, after borrowing his money and purchasing his house, with very little paid on it, what happens?"

Precisely the same thing happens as if he borrows money from any other source and defaults in payment—the mortgage is foreclosed. In closing out the transaction, if any money remains to his credit on the books of the society, it is returned to him.

"If the house should burn down, what happens?"

The association has been made secure, from the time the money was lent to buy it, by a paid-up policy of insurance, which the purchaser has paid for.

"Does the purchaser then lose in that event the money he has laid out in the paid-up policy?"

The owner of the house stands in precisely the same relation as that he would be in if his house was not mortgaged; the insurance policy being transferred only as collateral security.

"What notice is required to draw out money and close connection with the association?"

One month's notice is usually required by the bylaws; but as a matter of fact, small amounts are usually paid on demand or without notice.

"Does the man who has borrowed money from the association for a house, and defaulted in payments after one or two years of prompt payments, have to wait until the closing of the association's accounts at the end of the seven or ten years to get what is put to his credit?"

The borrower who has defaulted, as heretofore explained, is in precisely the same position as a borrower (from an individual) who fails to pay his debts. He is liable to have his house sold under foreclosure proceedings. His shares of stock (heretofore given to the society as collateral security) are forfeited; but after the society's claims have been satisfied, if anything remains to his credit (which is but seldom the case), it is paid to him at once.

"When a member who has taken thirty shares, after paying thirty dollars each month for a year or two, wishes to decrease his number of shares, being able to pay only ten or fifteen dollars a month, can he sell out his twenty or fifteen shares to somebody else?"

He can drop them, conveying them to the association, the other members of which thus become the richer by gaining the interest which would have been put to his credit for that number of shares, had they continued to stand in his name until the closing up of the association's accounts, or, as it is called, the maturing of the shares.

"Can any new member buy them at that time, or does the association only include the persons it originally started with?"

Anybody can buy the shares; but they must be transferred in the presence of the secretary, or the transfer must be attested by him.

The interest charged is six per cent. When the borrower paid two per cent. premium for the privilege of getting the money, in addition to the six per cent., it is easy to see how quickly the rolling snowball of the building association (unlike the rolling stone) grew larger and larger, and brought its members to their desired haven earlier.

The desired haven is the maturing of their shares of stock. Let it be remembered that one share of stock is allotted to every member who pays one dollar a month for a term of years. He agrees to pay this until each share becomes worth two hundred dollars. If the association prospers, lends its money freely, its accumulations may be gathered in ten or eleven years. The benefits of building associations to thrifty young men and women are these, that the shareowners or stockholders, the members who have agreed to pay one or more dollars a month for so many years, get the benefit of having their savings put out at high interest, because the man or woman who is purchasing a house on this plan is willing to pay even more than he paid to a landlord as rent, in order to own and live in his his house surely and speedily.

As it works, you see, the condition of being pledged to make monthly payments is an excellent spur and wholesome restraint upon extravagant habits among the members of building associations. You have got to keep up or fall out of the extended benefits that membership gives, and so most people try to keep up.

One questioner, returning to the charge, asks: "Does the borrower get anything besides buying his house?"

This question cannot be answered by "yes" or "no;" but may be by repeating a simple account of the societies. Consider one of these societies first as a simple savings bank. A number of members or stockholders agree to pay one dollar per month until each has accumulated two hundred dollars in a strong box, when each is to take out his two hundred dollars and the society is to dissolve. It will take two hundred months to do that if the money is kept in the box. If it is put out at interest, the time will be lessened in proportion to the earnings of the money. So the money is lent out at interest, and the society ends in *less* than two hundred months. That is all there is of one phase of a building society.

But it lends money and collects interest. Put it that the borrowers are *not* members, and that part of the business becomes simple enough. The society, of course, requires security; it, of course, requires prompt payment of interest, and, of course, seizes the property of those who do not pay and makes itself whole. Now, conceive that the end has been reached, and it is discovered for the first time that all the borrowers are, in fact, shareholders or members. What then happens? The borrower, let us say, owes two hundred dollars, which he got years ago, and on which he has been paying interest. He must pay to the society the principal of this debt, two hundred dollars. But he is a shareholder; the society owes him two hundred dollars for a matured share of stock. With some people it is absolutely necessary to hand the borrower two hundred dollars, and let him hand it back again, in order that they may understand the transaction, but others can see that, if the society marks its claim satisfied, and the member gives his receipt for the value of the share of stock, the same end is reached without the use of any money. This is what is meant when it is said that "the share of stock cancels the loan." Of course, a borrower who has already received his two hundred dollars does not get anything more when the society runs out. His gain, like that of the non-borrower, comes from the fact that, instead of having paid in two hundred dollars in two hundred months, he has probably paid in only one hundred and thirty-two dollars in one hundred and thirty-two months, yet has got the full value of two hundred dollars for each of his shares.—*Public Ledger*.

ELIAS PARKMAN NEEDHAM.

THE inventor whose persistent study developed the parlor or cabinet organ from the old melodeon, whose acute penetration discovered a quarter of a century ago the principle which underlies the practicability of the pneumatic carrying tubes of to-day, and whose

ELIAS PARKMAN NEEDHAM.

genius gave birth to perforated paper automatic music, died on the 28th day of last month. His name was Elias Parkman Needham.

He was born September 29, 1812, in Delaware County, of this State. His father, Daniel Needham, was a builder and architect of great local repute; but, with the restlessness of the pioneer, he left the section where his services were in strong demand, and, when Elias was four years old, emigrated to the then wilder region of Erie county, where he established a farm and grew into large esteem with the citizens of the near village of Sardinia. As a boy Elias attended for a few months each winter at the district log schoolhouse, but his early education was mostly accomplished by the rigorous demands of a newly cleared farm. This early work was faithfully done, but, as an evidence that agriculture was not exclusively to his taste, may be mentioned the fact that while a mere youth he astonished his father and brother by alone planning and building a two-story house. Indeed before he had reached the age of twenty-one he had made a bargain for the remainder of his time as a minor, and determined to seek his fortune through the exercise of the joiner's trade.

He soon gravitated to the growing city of Buffalo, where, though backed by but a slight experience in his calling, he found ready employment as a careful and skillful worker in wood. His ambition, however, was not to be satisfied with weekly wages. To become his own master he tried store-keeping for a few years and kept his eyes open for opportunities to invest his savings in some manufacturing business. Not recognizing his own latent talent as an inventor, he became the friend and adviser and co-worker of inventors. Ketchum and his reaping machine attracted his capital and labor for a short time, but finding that many shares in the reaper patents had passed into indifferent hands, he finally sold his own interest in them, and, having married in 1840, looked about for some investment that would secure the support of his growing family. Jeremiah Carhart was his admired friend. Carhart had his head full of novel ideas, and in his little turning shop were many models in various stages of enthusiastic construction and dusty neglect. Carhart knew not how to make his projects earn his living. Mr. Needham saw in one of them, the melodeon, the promise of a fortune, and induced Carhart to abandon job turning and to join in the establishment of a copartnership under the title of Carhart & Needham, and in 1846 this new firm began the industry which to-day employs so much capital and labor as the reed and reed organ business.

After a successful start in Buffalo, Carhart & Needham sold their business there, and came to New York City in 1848 for a wider field. From modest quarters in Forsyth Street, they soon removed to larger premises in Thirteenth Street, and at last built a spacious factory in East Twenty-third Street, opposite the Free Academy, now the City College. The firm name changed to Carhart, Needham & Co., again to Carhart & Needham, and finally to E. P. Needham & Son. With an admiring regard for Carhart's talents, Mr. Needham at first left entirely to his partner the inventing and improving department of the business and devoted himself with wonderful success to the construction and sale of instruments which, for durability and finish, should make a lasting reputation for his firm. But when his old partner's health and powers began to fail, Mr. Needham proved fully capable of filling the place to which he had never seemed to aspire. It was he who saw the possibility of building up the melodeon—thus far but a double-reed instrument—into a fair substitute for the pipe organ. His experiments in combining sets of reeds of varying quality soon led to his patented upright action, which permitted the government of twelve or more registers, in a single instrument, through the agency of stops and pedals, similar in external appearance to those of the large church organ. Many other improvements followed, and earned for the "Needham" or "Silver Tongue" a brilliant reputation among the goods with which rival firms at last flooded the market.

Mr. Needham was an ardent supporter of the government throughout the rebellion, and during the temporary suspension of general business gave up his factory to the manufacture of hand grenades, millions of which were used in the war.

Mr. Needham attended with unremitting closeness to his business, but his thoughts, led by his favorite paper, the SCIENTIFIC AMERICAN, often culminated in novel inventions outside of the department of music. He was much interested in the early London experiments in passenger pneumatic ways, and in 1864 patented the most radical and striking improvement yet made in the transmission of passengers and goods through tubes. His plan involved the generation through an endless system of tubes of a continuous circuit of air, with suitable valves or stops, and connecting branches or turnouts for the current at the stations, and whereby both suction and blast are made available without drawing air from the outside, or throwing air in motion away into the atmosphere; the air taken from one end of the circuit being driven into the other, and the whole column of air never of necessity being brought to a state of rest to stop the cars; thus getting the entire benefit of the accumulated force.

This invention, now practically in wide use for parcel tubes, was patented by Needham long before the world was ready for its adoption, and he never realized any money reward for the discovery.

In about the year 1878, Mr. Needham conceived the idea of using strips of perforated paper for the automatic production of music, and this conception issued in his latest patented invention—the automatic organ or orguinette—now manufactured in various forms. Mr. Needham's interests in this new discovery were protected by some fifteen or more patents, the sale of which, to the Mechanical Orguinette Company, of this city, practically closed the active business career of the inventor. Always deeply engrossed with his work, never allowing himself recreation or vacation, he at last began to experience the weakening results of a life of close and unremitting application to business. But into the period of a rather early old age he carried his old time courtesy, love for his fellows, reverence for his God, and that sturdy honesty which throughout his career made his word as acceptable as his bond. His funeral was largely attended by workmen who never have forgotten his kindly treatment as their employer.

ARID LANDS OF THE UNITED STATES.

MAJOR JOHN W. POWELL, Director of the Geological Survey at Washington, addressed the Chamber of Commerce of New York City, December 5, 1889, explaining his plan for the proposed redemption of arid lands in the West by irrigation. About one-half of the lands of the United States, he said, exclusive of Alaska, were arid. He said that his proposition presented these problems:

"*First.*—That capital to redeem by irrigation 100,000,000 acres of land is to be obtained, and $1,000,000,000 are necessary.

"*Second.*—These lands are to be distributed to the people, and as yet we have no proper system of land laws by which it can be done.

"*Third.*—The waters of the land must be divided among the States, and yet there is no law for it, and the States are now in conflict.

"*Fourth.*—The waters are to be divided among the people, so that each man may have the amount necessary to fertilize his farm, and each hamlet, town, and city the amount necessary for domestic purposes, that every thirsty garden may quaff from the crystal waters that come from the mountains.

"*Fifth.*—The great forests that clothe the hills, plateaus, and mountains with verdure must be protected from devastation by fire and preserved for the use of man, that farms may be protected and homes built, and that all this wealth of forestry, these unborn cottages and schoolhouses, may be distributed among the people.

"*Sixth.*—The grasses that are to feed the flocks and herds must be protected and utilized.

"*Seventh.*—The great mineral deposits, the fuel of the future, the iron for the railroads, and the gold and silver for our money must be kept ready to the hand of industry and the brain of enterprise.

"*Eighth.*—The powers for the factories of that great land are to be created and utilized, that the hum of busy machinery may echo among the rocks of the mountains, the symphonic music of industry."

Major Powell demanded that the work should be done by private enterprise and not by the government. Furnish the people with institutions of justice, he said, and let them do the work for themselves. This was the proposition:

"That the entire arid region be organized into natural hydrographic districts. Each such community should possess its own irrigation works; it would have to erect diverting dams, dig canals, and construct reservoirs, and such works would have to be maintained from year to year. The plan is to establish local self-government by hydrographic basins, and each basin may well constitute a great county. Let there be established in each district a court to adjudicate questions of water rights, timber rights, pasturage rights, and power rights, in compliance with the special laws of the community and the more general laws of the State and the nation. Let the people of the district provide their own officers, for the management and control of the waters, for the protection and utilization of the forests, for the protection and management of the pasturage, and for the use of the power.

"With district courts, water masters, herders, and foresters they would be equipped with the local officers necessary for the protection of their own property and the maintenance of individual rights. The interests are theirs, the rights are theirs, the duties are theirs. Let them control their own actions.

"Give them local self-government in all these particulars. Then the hydraulic works are to be constructed. To some extent this can be accomplished by co-operative labor. But ultimately and gradually great capital must be employed in each district. Let them obtain this capital by their own enterprise as a community. Constituting a body corporate, they can tax themselves and they can borrow moneys.

"For security they have a basis of land titles, water rights, pasturage rights, forest rights, and power rights. All of these would furnish ample security for the necessary investments, and these district communities having it in their power to obtain a vast unearned increment by the development of the lands, and to distribute it among the people in severalty, will speedily learn how to attract capital by learning that honesty is the best policy.

"Each State should provide courts for the adjudication of litigation between people of different districts, and courts of appeal from the irrigation district courts. It should also provide a general inspection system and provide that the greater irrigation reservoirs shall not be constructed in such a manner as to menace the people below and place them in peril of life from floods. And, finally, it should also provide general statutes regulating water rights.

"But the general government must bear its part in the establishment of the institutions for the arid regions. It is now the owner of the lands, and it must provide for the distribution of these lands to the people in part, and in part it must retain possession of them, and hold them in trust for the districts. It must also divide the waters of the great rivers among the States. See, then, how all this can be accomplished.

"Let the government make a survey of the lands, segregate and designate the irrigable lands, the timber lands, the pasture lands, and the mining lands; then let the general government retain possession of all but the irrigable lands, but give these to the people in severalty as homesteads, and require that each homestead shall be actually developed by the construction of irrigating works in order to obtain title thereto.

"Then, further, let the general government declare and provide by statute that the people of each district may control and use the timber, the pasturage, and water powers, under specific laws enacted by themselves and by the States to which they belong. Then let the general government further declare and establish by statute that the water of each district may be used within that district on the land segregated as irrigable lands. By this means the water would be regulated to the several districts, and all inter-state problems would be solved, and the national courts could settle all inter-state litigation.

"But the mining industries of the country must be considered. Undeveloped mining lands should remain in the possession of the general government, and titles thereto should pass to individuals under provisions of statutes already existing, where such lands are obtained only by actual occupation and development, in quantities sufficient for mining purposes only.

"Then, mining regions must have mining towns. For these the town sites laws already enacted provide ample resource.

"It is thus proposed to divide responsibility for these institutions between the general government, the State governments, and the local governments. Having done this, it is proposed to allow the people to regulate their own affairs in their own way; borrow money, levy taxes, issue bonds, as they themselves shall determine, construct reservoirs, dig canals when and where they please, make their own laws and choose their own officers, protect their own forests, utilize their own pasturage, and do as they please with their own powers."

It should be remembered, said Major Powell, that the far West was no longer an uninhabited region. In almost every great hydrographic basin there could be found a population sufficient for the organization of the necessary irrigation districts. The people were intelligent, industrious, enterprising, and wide awake to their interests.

In closing Major Powell said:

"The effort has been to present a plan by which the agriculture of the arid lands may be held as a vast field of exploitation for individual farmers who cultivate the soil with their own hands, and at the same time and by the same institutions to open to capital a field for safe investment and remunerative return, and yet to secure to the toiling farmers the natural increment of profit which comes from the land with the progress of industrial civilization. The great enterprises of mining, manufacturing, transporting, exchanging, and financiering in which the business kings of America are engaged challenge admiration, and I rejoice at their prosperity, and am glad that blessings thus shower upon the people; but the brilliancy of great industrial operations does not daze my vision. I love the cradle more than the bank counter. The cottage house is more beautiful to me than the palace. I believe that the schoolhouse is primal, the university secondary; and I believe that the justice's court in the hamlet is the only permanent foundation for the supreme court at the capital."

WOOD LILIES.

(TRILLIUMS.)

THIS remarkable genus of North American plants includes a few of the most singular and striking of all hardy plants, but, with the exception of T. grandiflorum, all the varieties are considered difficult to manage, this in a large measure accounting for their scarcity in gardens. It is true they are difficult to cultivate if care is not taken to choose the proper position and soil. For instance, to plant even the strong growing T. grandiflorum in the ordinary flower border would be a certain way of courting failure. If trilliums are planted in a properly prepared soil in a somewhat shady situation, no fear need be felt as to success. Trilliums require a peaty or vegetable soil, free, deep, and well drained, as they are most averse to stagnant moisture about their roots.

In an artificial bog or by the edge of a pond they thrive admirably when fairly established, and in such positions they are very effective. Their natural element, however, and the position in which I have found them always do best, is as edgings to such plants as azaleas, dwarf rhododendrons, kalmias, and other evergreen shrubs, as they are thus efficiently protected from cold winds in early spring. Few plants indeed adapt themselves more readily to shady nooks, and when once established they require little or no attention. The stronger growing varieties might with advantage be naturalized in shady woods, and if this could be managed properly, what a charming picture they would present through the spring months. The best and most useful of the group is the old T. grandiflorum (here figured). It grows from 1 foot to 3 feet in height, the large, trifoliate, and handsome leaves being surmounted by large spotless white flowers. The latter are borne on short stalks and droop conveniently so as to show to the best advantage. It blooms early in April and May.

THE LARGE WHITE WOOD LILY (TRILLIUM GRANDIFLORUM).

T. sessile has broadly rhomboid leaves, the flowers purple brown; the variety californicum is, however, the best. It is much stouter, with broadly oval leaves, 3 inches to 6 inches long, the large flowers rose colored or white. This is a handsome species, very easily managed. T. recurvatum has oval leaves and small purple brown flowers. T. erectum is a common species, with usually brown purple flowers, varying to white or pink. Others equally beautiful and desirable are erythrocarpum, a most beautiful species, cernuum, ovatum, petiolatum, etc. With the photograph from which the accompanying engraving was taken we received the following interesting note from the sender, Lieut.-Col. J. R. Kelsall:

These were grown from roots picked up in the woods in Canada three years ago; they are, of course, perfectly hardy, but I have to grow them in pots, as the slugs devour them in the open ground. The pot in which those illustrated grew was in a corner of the garden all last winter, and was taken into the house as soon as the young shoots appeared above ground. The lily-like white flowers are very graceful and pretty, and remain a long time in beauty. The plants grew to a height of 15 inches or 18 inches.—*D. K., in the Garden.*

AN EXPERIMENT IN COLOR-BLINDNESS.*

By JOHN SPILLER, F.I.C., F.C.S.

EXAMINATION of several color-blind persons having convinced me of the practical value of a compound tassel of green and gray silk cords as a preliminary indicator of defective color vision; and, moreover, having studied Professor William Pole's interesting memoir—describing his own case—in the *Philosophical Transactions of the Royal Society*, April, 1859, which is illustrated by a diagram, showing bands of "neutral gray" appearing to him in the middle of the green and at the deepest red, or crimson, of Chevreul's colored *cercle chromatique*, I felt very desirous of trying an experiment to see for myself whether it was possible by the administration of a small dose of santonine—which is said to cause temporary color-blindness—to realize in my own case the imperfection of vision which seems common to most color-blind patients.

Such an experiment I made on the 29th of August; but before proceeding to describe the result it should be mentioned that I have good proof of my being blessed with the possession of a normal sight; for in the course of a long experience with coal tar colors, and having frequent occasion to compare observations with regard to slight differences of tint with my six colleagues, I have never perceptibly deviated from the consensus of the laboratory staff, and may fairly claim to be reliable on this score. On a fine day, provided with an ample selection of chemical specimens and colored objects, and Ladd's direct vision spectroscope ready to hand, I took, fasting, a small dose of santonine, a grain and a half, dissolved in a small quantity of alcohol and diluted with water. In less than five minutes the drug had taken effect; the white table cloth appeared of a delicate bluish green color, pale turquoise, exactly like the colors of the *Nineteenth Century Magazine*, and all objects were seen as through spectacles of that precise tint. A rapid survey was made of my varied collection of objects, and I went into the garden to use my spectroscope. I could see all the solar colors in unbroken series with scarcely perceptible variation; the Fraunhofer lines were there as usual (not thickened), the violet extending up to the usual limit, and so with the red end, with slightly diminished brilliancy, but hardly appreciable absorption; there was *no neutral gray band in the green*, but this portion of the spectrum appeared quite normal and splendidly brilliant. The observation was repeated a few minutes later with the same result.

Turning to my colored specimens. Nickel, copper, and iron sulphates, iodide and chromate of lead, ultramarine, and ammonio-sulphate of copper, were quite normal; oxalate of cobalt had not lost its delicate pink color, nor nitrate of uranium its well known shade. On the other hand, scarlet iodide of mercury was decidedly dulled, and a fine sample of carmine appeared more like crimson. By running my eyes along the book shelves in my library, I soon noticed that "Gmelin's Chemistry"—Cavendish Society series—and other old fashioned green bindings assumed a kind of slaty appearance, crimson backs appeared as maroon, dark brown was converted to chocolate, but I could see violet quite well, bright green pretty much as usual; the *Chemical News*, bound in scarlet, appeared red, and neutral gray bindings looked only darker in color. I could see quite distinctly the difference between light green and slate gray silk tassels, so that my condition was not so abnormal as many of my color-blind friends, who fail to see any radical tint distinction between these two dissimilar colors.

Now for a word of caution. I had taken only what might be described as a quarter dose—"2 to 6 grains" is the stated quantity in "Martindale's Extra Pharmacopœia;" other authorities say more—but at the end of fifteen or twenty minutes, the tension upon my nervous system proved so serious that I feared the worst consequences. I felt so giddy and depressed, with a kind of mild tetanus, that I was obliged to resort to an emetic—mustard and warm water—which soon gave me relief. I would earnestly warn my readers of the danger of repeating this experiment; and now on fuller inquiry I learn that santonine is a drug reported to be "sometimes uncertain in its action," and occasionally developing "poisonous symptoms from its depressing effects on the nervous system." I had read of Dr. W. G. Smith taking a 5 grain dose to induce color-blindness—"Cooley's Cyclopedia of Practical Receipts," p. 1460—without dangerous consequences, and resolved to take a very much smaller quantity, $1\frac{1}{2}$ grains, in the first instance, well knowing that more than this had often been given to children. Perhaps

* Read before the British Association, Section A, Newcastle meeting.

taking it in the state of solution, and before breakfast, or a wrong dose, made all the difference. However that may be, I shall never again try ophthalmic experiments with santonine, and would warn others against doing so without proper medical advice.

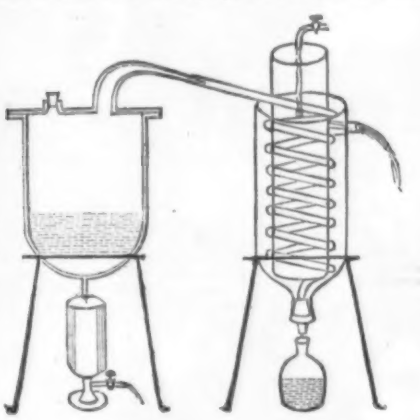
My object is accomplished. I wanted to search for Professor Pole's natural gray bands in the solar spectrum, as he sees them in Chevreul's famous *cercle chromatique* diagram, but I did not see them. Nor, it may be added, do any of my color-blind friends see any break in the solar spectrum, although we know that the heavy green pigments are by them so often mistaken for gray. Furthermore, it does not appear that santonine gives the *same kind* of color-blindness as commonly presented by the natural defect, or my color test of green and gray would at once have indicated it.

London, September 2, 1889.

ESTIMATION OF SILICA.

By GEORGE CRAIG.

THE process in most general use for estimating silica is, I believe, to fuse with alkaline carbonates and decompose with HCl, with subsequent evaporation to dryness. From many experiments it seems that no more than 97·5 per cent. of the total silica can be obtained when pure silica or siliceous matter is subjected to the treatment just mentioned. The subsequent estimation of the silica remaining in solutions is a very tedious operation, and unsatisfactory after all. By decomposing with H_2SO_4 this difficulty may be overcome, and all the silica obtained insoluble; but the large amount of alkaline salts, introduced for purposes of fusion, necessitates the re-solution and re-precipitation of the Al_2O_3, MnO_2, CaO, and MgO, precipitates obtained in the filtrate from the silica. Thereby ammonia and soda salts increase to such an extent that their solvent action on the precipitates and on the operation vessels becomes considerable. So much is this the case that, by evaporating the filtrate from the MgO precipitate to dryness in a platinum basin, expelling all volatile salts, dissolving in water, and rendered alkaline with Na_2CO_3, a considerable precipitate is obtained, consisting of SiO_2, Al_2O_3, CaO, MgO, and P_2O_5. The unreliability of figures obtained under such circumstances caused me long ago to discard the fusion



process, and in all cases to expel SiO_2 with HF and H_2SO_4, and estimate the other ingredients in the residue.

As may be imagined, careful analyses of the same material by both processes, using glass and porcelain vessels, show considerable differences, and there can be no doubt which is the more correct. I have no doubt this process is used by a great number of chemists; but the publication, ever and anon, of analyses performed by fusion processes convinces me that the errors inherent to the one and the accuracy and rapidity of the other are not sufficiently known—hence this communication.

For the expulsion of the silica, sufficiently pure H_2SO_4 may be had from the dealers, which is best employed after dilution with an equal volume of water.

Commercial HF requires to be redistilled, and for this purpose is introduced into a 10 or 12 oz. capacity leaden retort and the vapors passed through a coil of red India rubber tubing (¼ in. bore) immersed in water.

The tubing is best wound spirally about a piece of 2 in. diameter glass tube, which serves to support it and, at the same time, to introduce the cold feed water at the bottom of the containing vessel, which is the same as that supplied with the ordinary spiral glass condensers. The arrangement is shown in the accompanying sketch. The first portion of the HF distilled is rejected, or it may be redistilled, as it is contaminated with impurities derived from the rubber, but after a little the distillate leaves no residue on evaporation.

A blank experiment should be performed by evaporating 100 grains of the H_2SO_4 to dryness with a little HF, and ascertaining the weight and nature of the ignited residue, so that it may be allowed for.

Process.—20 or 25 grains of the very finely ground material are placed in a deep platinum crucible and H_2SO_4 added in quantity more than sufficient to form sulphates with all the bases present. About 50 grains bulk of the pure HF is added, and, after mixing well by shaking gently, the crucible is kept over the lowest flame of an Argand until almost dry. One treatment with HF is usually sufficient to expel all the SiO_2, but for surety I always repeat the operation, and heat more strongly at the finish *until* H_2SO_4 *is evolved.*

This is the only point requiring special attention, for fluorides are formed, and no amount of heating with excess of H_2SO_4 decomposes them unless the heating is continued until H_2SO_4 itself is evolved. By neglecting this no end of trouble may be incurred thereafter by the precipitation of fluorides, and totally erroneous results will be obtained.

As the white fumes, toward the finish, may easily be mistaken for H_2SO_4, I invariably test the fumes by holding a glass rod moistened with dilute NH_4HO in them and dipping it into a test tube containing dilute acidified $BaCl_2$; no precipitate is given until H_2SO_4 is present. When the crucible has become cold, HCl is added and gentle heat applied, until all is dissolved. By covering the crucible with a platinum capsule filled with cold water, which can be withdrawn and renewed by means of a pipette when it becomes warm, condensation of the HCl vapors takes place, all loss by spurting is avoided, and solution hastened.

When thoroughly dissolved, the acid solution is washed into a beaker, diluted, and the alumina and other ingredients estimated as usual. When precipitating the Al_2O_3, etc., I prefer to color the solution with litmus, add NH_4HO till just blue, and filter whenever the precipitate settles, thus avoiding all chance of error from the solution of the ingredients of the glass by long boiling.

The precipitate is washed with water containing a little NH_4NO_3, until the filtrate is free from SO_3, but, as it may still contain some basic sulphate, it may be redissolved. This, however, is unnecessary, as after ignition for some time at a high temperature over a blowpipe, the precipitate never contains more than immaterial traces of SO_3. This precipitate contains all the Al_2O_3, TiO_2, Fe_2O_3, P_2O_5, and a little Mn_3O_4. The bulk of the manganese, practically all when not much is present, remains in the filtrate, and is precipitated by NH_4HO and bromine water. CaO and MgO are estimated in the filtrate.

Alkali is estimated by Lawrence Smith's process. By weighing as sulphate, estimating, and deducting the SO_3, the amount of $(KNa)_2O$ is obtained more rapidly than otherwise, and, if required, the proportion of K_2O and Na_2O can be obtained from these data by calculation.

Lugar Iron Works, Cumnock, N. B.

—*Chem. News.*

THE weight of horse fat remains unchanged for about four weeks. In the course of two years the increase due to the absorption of oxygen and the formation of free acids amounts to 3·495 per cent.—*Zeit. Anal. Chem.*

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TABLE OF CONTENTS.

The Scientific American Supplement. Index for Vol. 28.

JULY—DECEMBER, 1889.

The * Indicates that the Article is Illustrated with Engravings.

762+ 8